TM 11-5820-469-30

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DIRECT SUPPORT MAINTENANCE MANUAL RADIO TERMINAL SET AN/TRC-80

HEADQUARTERS, DEPARTMENT OF THE ARMY

OCTOBER 1964

WARNING

Be careful when working on the 200-volt dc high voltage circuits or on the 120- and 208-volt ac line connections.

DON'T TAKE CHANCES!

DANGEROUS RF VOLTAGES ARE EXPOSED ON THE ANTENNA.
EXTREMELY HIGH VOLTAGES EXIST IN THE FOLLOWING UNITS:

Klystron drawer	7,700 volts
Amplifier-Converter AM–3303/TRC–80	1,600 volts

GASOLINE HANDLING

Do not refuel the power unit and do not handle or leave open gasoline containers or plastic gasoline containers in the vicinity of the radio set while the transmitter is on. Do not smoke or light open fires within 25 feet of the gasoline containers or the engine generator.

RF BURNS

Do not stand on the roof of the shelter or in the path of radiation from the radio set while the transmitter is on. Turn off the power amplifier before climbing to the shelter roof.

WIND WARNING

Do not assemble or disassemble the antenna when wind gusts exceed 60 mph or sustained winds exceed 40 mph.

RADIATION HAZARD

STD-RW-2

Co60
Ni63

Tube-types OA2WA and OB2 are used in this equipment and contain radioactive material (TM 11–5820–469–10). These tubes are potentially hazardous when broken; see qualified medical personnel and the safety director if you are exposed to or cut by broken tubes. Use extreme care in replacing these tubes and follow safe procedures in their handling, storage, and disposal (TM 11–5820–469–10).

Never place radioactive tubes in your pocket.

Use extreme care not to break radioactive tubes while handling them.

Never remove radioactive tubes from cartons until ready to use them.

Refer to TM 11–5820–469–10 on handling, storage, and disposal of radioactive material.

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *6 October 1964*

Direct Support Maintenance Manual

RADIO TERMINAL SET AN/TRC-80

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*This manual supersedes the direct support portion of TM 11-5820-469-35, 2 April 1962, and supersedes C 2, 29 October 1962 in its entirety.

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CHAPTER 1

INTRODUCTION

1. Scope

a. This manual covers direct support of Radio Terminal Set AN/TRC–80. Installation, operation, and organizational maintenance are covered in TM 11–5820–469–10 and TM 11–5820–469–20.

b. Direct support of the AN/TRC–80 consists of troubleshooting, removal and replacement of parts, repairs, adjustments, and testing procedures that are within the scope of direct support personnel. The purpose, operation, and interoperation of the various circuits in this equipment are explained in chapters 2 through 15.

c. The direct reporting, by the individual user, of errors, ommissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended Changes to DA Publications) will be used for reporting these improvements. This form will be completed in triplicate by the use of pencil, pen, or typewriter. The original and one copy will be forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL–MR–MP–P, Fort Monmouth, N. J. 07703. One information copy will be furnished to the individual's immediate supervisor (officer, noncommissioned officer, supervisor, etc.).

2. Index of Publications

Refer to the latest issue of DA Pam 310–4 to determine whether there are new editions, changes, or additional publications pertaining to this equipment. DA Pam 310–4 is an index of current technical manuals, technical bulletins, supply manuals, supply bulletins, lubrication orders, and modification work orders available through publication supply channels. The index lists the individual parts (–10, –20, and –35P, etc.) and the latest changes to and revisions of each equipment publication.

3. General Information

a. The interunit coaxial cabling diagram is located in TM 11–5820–469–20. The rack wiring diagram (fig. 189) is container in this manual.

b. Simplified schematic diagrams used to supplement the circuit function text in this manual are functional segments of complete schematic diagrams which are located at the back of this manual.

c. Refer to paragraph 6, TM 11–5820–469–10 for nomenclature and common-name assignments used throughout this manual.

d. Maintenance of Terminal, Telegraph TH–5A/TG and Teletypewriter TT–335/TG is covered in separate manuals. Refer to the appendix for the numbers of the technical manuals.

e. Refer to TM 11–5820–469–20 for a simplified block diagram of the AN/TRC–80.

CHAPTER 2

FUNCTIONING OF DEMULTIPLEXER MULTIPLEXER TD–550/TRC–80

Section I. BLOCK DIAGRAM

4. General
(fig. 151)

a. The function of Demultiplexer-Multiplexer TD–550/TRC–80 (multiplexer) with respect to the other functional units of the AN/TRC–80 is covered in TM 11–5820–469–20. The multiplexer accepts one voice channel and a teletypewriter (tty) channel. The tty signal is heterodyned with an injection signal from a crystal-controlled local oscillator to place the tty channel above the voice channel frequency. The voice and the frequency-multiplexed signals are then combined to form a multiplexed output signal. This signal is used as the modulating signal for the modulator-multiplier (para. 27*a*). The multiplexer also accepts the detected multiplex output of the received signal from the IF amplifier (para. 101*f*) and separates the voice and radio tty signals. The tty signal is mixed with an injection signal to recover the proper mark and space signals for teletypewriter operation.

b. The multiplexer consists of the following:
(1) Transmit section.
(2) Receive section.
(3) Local oscillator circuit.
(4) Power supply.

5. Transmit Section
(fig. 151)

The tty signals or local microphone signals generated by the local AN/TRC–80 operator, or the voice and tty signals from external landlines, are applied to the transmit section of the multiplexer. The signals are amplified, filtered, combined, and applied as a composite multiplex signal to the modulator-multiplier (paras. 26 through 48).

a. Line Voice Input. Voice signals, in the 300- to 3,500-cycle-per-second (cps) frequency range, from the control panel (paras. 159 through 185) are applied to clipper amplifier V1. Undesirable peaks present in the voice signal are clipped by V1.

b. Local Microphone Input (not used in the Pershing Weapons System configuration). Voice signals from the local microphone are coupled to amplifiers V9A and V9B. The voice signals coupled to V9A are amplified and applied to the local headset as a sidetone signal. The voice signal coupled to V9B is amplified and coupled to clipper amplifier V1.

c. Voice Signal Path. The voice signal output of clipper amplifier V1 is coupled to low-pass filter FL1. This filter rejects all frequencies above 3,500 cps, thereby removing any high-frequency components that may have been produced by the clipping action of V1. The output of the low-pass filter is coupled to combiner amplifier V6.

d. Tty Signal Path. The outgoing tty signal, consisting of mark and space signals at 1,325 and 1,225 cps, respectively, from the control panel (paras. 159 through 185), is coupled to mixer V2. In addition to the tty signal, a 3-kilocycle (kc) injection signal is coupled to mixer V2. The tty and injection signals are heterodyned in the mixer. The output of V2 is coupled to bandpass filter FL2. Filter FL2 passes only signals in the 4,225- to 4,325-cps frequency range. The sum of the space signal and the injection signal (4,325 cps), and the sum of the mark signal and the injection signal (4,225 cps) are passed by the bandpass filter and coupled to combiner amplifier V6. All other

frequencies produced by mixing the tty and injection signals are rejected by FL2.

e. Combiner Amplifier V6. The voice and tty signals are amplified and combined in combiner amplifier V6. The output of V6 is a multiplexed signal in the 300- to 4,325-cps frequency range applied to the modulator-multiplier (para. 27).

6. Receive Section
(fig. 151)

Multiplexed signals from a distant AN/TRC-80 are coupled from the IF amplifier assembly (para. 97) to the receive section of the multiplexer. The 300- to 4,325-cps multiplex input signal is separated into voice and tty signals and applied to the control panel (paras. 159 through 185).

a. Voice Signal Path. The multiplex input signal is coupled through cathode follower V8B to low-pass filter FL5. The voice signals in the 300- to 3,500-cps frequency range are passed by FL5. All other signals are rejected. The output from FL5 is applied to amplifiers V5A and V5B. The amplified output of V5A is coupled to the local headset. The amplified output from V5B is applied to the control panel.

b. Tty Signal Path. The incoming multiplex signal is coupled through cathode follower V8A to bandpass filter FL4. The 4,225- to 4,325-cps tty signal component is passed by FL4. The output of FL4 is coupled to mixer V4, where it is heterodyned with the 3-kc injection signal. The output of mixer V4 is coupled to bandpass filter FL3. The frequency difference of the mark signal and injection signal (1,325 cps) and the frequency difference of the space signal and injection signal (1,225 cps) are passed by FL3. The output is amplified by V3A and applied to the control panel.

7. Oscillator Circuit
(fig. 151)

The oscillator circuit generates the injection signal that is heterodyned with the tty signals. The oscillator output is also used for operator signalling.

a. Oscillators V7A and V7B. Crystal-controlled oscillators V7A and V7B produce two frequencies at approximately 1-megacycle (mc). These two frequencies are separated by 3 kc. The outputs of the two oscillators are heterodyned, and a resonant circuit selects the 3-kc difference signal, which is coupled to cathode follower V3B.

b. Cathode Follower V3B. Cathode follower V3B isolates the oscillator stage from the loading effect of the following stages. The output of V3B is coupled to mixers V2 and V4 and to pushbutton S2. When S2 is depressed, the 3-kc signal is coupled to V1 to be used as a signaling tone. This signal takes the same path as the voice signal and is used to alert the operator at the distant station.

8. Multiplexer Power Supply
(fig. 151)

a. Filament and plate supply voltages are produced by a power supply mounted on the multiplexer chassis. Single-phase 120 volts alternating current (ac) is applied to transformers T9 and T10. The 6.3-volt ac output at the secondary of T10 is applied to the filaments of vacuum tubes V1 through V9.

b. The output at the secondary of T9 is rectified by silicon diodes CR1 through CR4. The rectified output is filtered and fed through time delay relay K1 and series-regulator tube V10 and serves as the B+ source for the multiplexer. Additional windings of T9 operate the heaters of V10 and V11 and crystal oven HR1 (not shown).

c. Time delay relay K1 permits the filaments to be heated for approximately 30 seconds before plate voltage is applied.

d. Series regulator V10 maintains a constant B+ supply voltage. Variations in the supply output voltage are amplified by differential amplifier V11 and coupled to regulator V10 as a control voltage which, in turn, causes V10 to increase or decrease the output voltage. Voltage-regulator tube V12 provides a reference for the cathode of differential amplifier V11.

Section II. TRANSMIT SECTION

9. General

The transmit section of the multiplexer consists of tubes V1, V2, V6, and V9, and two filters, FL1 and FL2. The transmit section accepts voice and tty signals at a level of 0 dbm (in this equipment 0 dbm is defined as 1 milliwatt across an impedance of 600 ohms) and serves as an amplifier and combiner for the two inputs. Circuit details for the transmit section are covered in paragraphs 10, 11, and 12.

10. Voice Channel

(fig. 152)

The voice channel consists of transformers T1 and T6, clipper amplifier V1, amplifier V9, and low-pass filter FL1.

a. Line Voice Input Circuit. Voice signals, in the 300- to 3,500-cps frequency range, from the control panel (para. 159) are applied between pins A and B of jack J10 and are inductively coupled to the secondary of transformer T1. High-frequency transients generated in the primary of T1 are shunted to ground by capacitors C1 and C2. Transformer T1 matches the impedance between the 600-ohm input line and the high-input impedance of V1. The signal across the secondary of T1 is coupled to the grid of V1A through impedance-matching resistor R1 and clipping level-adjust control R2. The setting of R2 determines the level at which voice clipping begins.

b. Clipper Amplifier V1. High-amplitude signals and instantaneous high-level noise peaks are clipped by clipper amplifier V1.

(1) Cathode follower V1A drives grounded-grid amplifier V1B which functions as a limiter when the signal amplitude exceeds a level determined by the bias on the tube. Clipping action occurs when the amplitude of the input signal increases and causes an increase in current flow through common cathode resistor R12. This action increases the bias on V1B, reduces the gain of the tube, and thus limits the peak output amplitude. Cathode resistor R12 also serves as the input impedance for V1B.

(2) The input signal at the wiper arm of R2 is applied to the grid (pin 3) of V1A. The output signal is developed across cathode resistor R12 and applied to the cathode (pin 8) of V1B. The amplified output of V1B is developed across plate load resistor R10, and coupled to low-pass filter FL1 through capacitor C11 and impedance-matching resistor R11.

c. Low-Pass Filter FL1. Filter FL1 is a low-pass filter with a cutoff frequency of approximately 3,600 cps.

(1) Audiofrequencies below 3,600 cps are passed by the filter with minimum attenuation, but frequencies above 3,600 cps and high-frequency components generater by the clipper stage are rejected.

(2) The output of FL1 is coupled to the grid (pin 3) of combiner amplifier V6 through voice-input level-adjust control R29. The setting of R29 determines the audio level applied to V6.

d. Local Microphone Input. Voice signals from the microphone portion of the local headset (normally not used in the Pershing Weapons System configuration) are applied between pins A and D of jack J11 and are inductively coupled to the secondary of transformer T6. Transformer T6 matches the impedance of the 600-ohm input line to the high-input impedance of amplifier V9. Capacitor C9 provides a low-impedance path to ground for high-frequency transients generated in the primary of T6. Power is applied to the headset microphone from pin 5 of T6. The signal across the secondary of T6 is coupled to the grid (pin 7) of V9B through impedance-matching resistor R8 and microphone level-adjust control R9. The signal is also coupled to the grid (pin 3) of V9A, through R8 and sidetone level-adjust control R27.

(1) The signal at the wiper arm of R27 is applied to the grid (pin 3) of V9A.

This signal is amplified by V9A, developed across plate load resistor R37, and coupled to the headset receiver through capacitor C29 and transformer T5. Control R27 sets the level of the sidetone signal applied to the headset receiver.

(2) The signal developed at the wiper arm of R9 is applied to the grid (pin 7) of V9B. The signal is amplified, developed across plate load resistor R24, and coupled to the grid (pin 3) of V1A through capacitor C18, impedance-matching resistor R62, and control R2. Microphone level-adjust control R9 determines the input level to V9B. The local microphone input to V1 is treated in the same manner as the line voice input (*a* above).

11. Radio Teletypewriter Signal Channel (fig. 152)

The radio tty channel consists of input transformer T2, mixer V2, and bandpass filter FL2.

a. Input Circuit. The tty input, consisting of mark and space signals (1,325 and 1,225 cps, respectively) from the control panel (para. 159), is applied between pins A and B of jack J9. The input is inductively coupled to the secondary of transformer T2. Capacitors C3 and C4 bypass high-frequency transients generated in the primary winding of T2. The output of T2 is coupled to the grid (pin 3) of mixer V2 through resistor R3 and tty-input level-adjust control R5. Resistors R4, R5, and R3 form an impedance-matching network. The setting of control R5 determines the level of the input signal applied to V2.

b. Mixer V2.

(1) The 1,225- and 1,325-cps tty signals are mixed with a 3-kc injection signal (paras. 17–19) to produce frequencies of 4,225 and 4,325 cps.

(2) The tty signal at the wiper arm of control R5 is applied to the grid (pin 3) of V2A. A 3-kc injection signal from cathode follower V3B (para. 19) is applied to the grid (pin 7) of V2B. Resistor R14 is the direct-current (dc) ground return for the grid of V2B. The two input signals mix in the common cathode circuit to produce sum and difference frequencies across plate load resistor R15. Resistor R16 and capacitor C13 form a plate-decoupling network.

c. Bandpass Filter FL2. Capacitor C12 couples all the frequencies at the plate circuit of mixer V2 to the input of bandpass filter FL2. Filter FL2 passes the sum frequency (4,225 cps) of the tty space signal and the injection signal, and the sum frequency (4,325 cps) of the tty mark signal and the injection signal. All other frequencies are rejected. The selected output of the bandpass filter is applied to the control grid of combiner amplifier V6B.

12. Combiner Amplifier V6 (fig. 152)

Voice and tty signals are combined to form a multiplex signal which is applied to the modulator-multiplier (para. 26).

a. The voice signal at the wiper arm of R29 is applied to the grid (pin 3) of V6A. The output of FL2 (4,225- and 4,325-cps space and mark frequencies) is applied to the grid (pin 7) of V6B. The two signals are amplified and combined across common plate load resistor R28.

b. The combined multiplex signal is coupled to the primary of transformer T7 by capacitor C26, and inductively coupled to the secondary of T7 and to jacks J5 and J6. Capacitor C30 bypasses high-frequency transients. Transformer T7 matches the output impedance of V6 to the 600-ohm output line. The multiplex signal, in the 300- to 4,325-cps frequency range, is applied to the modulator-multiplier (para. 27).

Section III. RECEIVE SECTION

13. General

The receive section of the multiplier accepts the multiplex signal from the output of the IF amplifier (para. 97), separates the voice from the tty signals, and functions as an amplifier. Circuit details for the receive section of the multiplexer are covered in paragraphs 14, 15, and 16.

14. Multiplex Input Circuit
(fig. 152)

A multiplex signal, in the 300- to 4,325-cps frequency range, from the IF amplifier, is applied to input jack J8. Jack J7 is the associated test jack. This signal contains voice and tty components recovered by the IF amplifier assembly. The signal at J8 is applied to the primary of T8 and is inductively coupled to the secondary. Transformer T8 matches the impedance of the 600-ohm input to the impedance of cathode followers V8A and V8B. The multiplex signal across the secondary of T8 is applied to cathode followers V8A and V8B through tty-output level-adjust control R41 and voice-output level-adjust control R42. Capacitor C33 bypasses high-frequency transients generated in the primary of T8.

15. Voice Channel
(fig. 152)

The voice channel consists of cathode follower V8B, low-pass filter FL5, amplifiers V5A and V5B, and transformers T4 and T5. Two outputs from this channel may be obtained; one output is applied to a local headset, and the other to the control panel (para. 159).

a. Cathode Follower V8B. The multiplex signal at the wiper arm of control R42 is applied to the grid (pin 7) of V8B. Cathode follower V8B matches the high-input impedance of the V8B grid circuit to the low-input impedance of low-pass filter FL5. The multiplex signal is developed across cathode resistor R36 and applied to FL 5 through impedance-matching resistor R35 and capacitor C25.

b. Low-Pass Filter FL5. Filter FL 5 functions the same as filter FL1 (para. 10*c*).

(1) Audiofrequencies below 3,600 cps are passed with minimum attenuation. The voice-signal components of the multiplex signal are passed, but the tty signal components are rejected.

(2) The output of FL5 is applied to amplifiers V5A and V5B.

c. Amplifier V5A. The local-headset output is amplified by V5A. Unbypassed cathode resistor R38 provides cathode degeneration, which, in turn, provides amplifier gain stabilization.

(1) The voice signal from FL5 is applied to the grid (pin 3) of V5A. The amplified output signal is developed across plate load resistor R37, and coupled to transformer T5 through capacitor C29.

(2) Transformer T5 matches the high-output impedance of V5A to the 600-ohm output line. The signal across the primary of T5 is inductively coupled to the secondary. The signal across the secondary of T5 is connected to pins D and E of jack J11. Capacitor C34 is a bypass for high-frequency transients.

d. Amplifier V5B. The line voice output of the multiplexer is amplified by V5B. Cathode resistor R38 is unbypassed for the same purpose as the cathode resistor of V5A (*c* above).

(1) The voice signal output of FL5 is also applied to the grid (pin 7) of V5B. The amplified output is developed across plate load resistor R22 and coupled to the primary of transformer T4, through capacitor C17.

(2) Transformer T4 matches the output impedance of V5B to the 600-ohm output line. The signal across the primary of T4 is inductively coupled to the secondary. The signal across the secondary is applied to test jack J4 and between pins D and E of jack

J10. Capacitors C7 and C8 provide a bypass for high-frequency transients. The signal at jack J10 is applied to the control panel.

16. Radio Teletypewriter Receive Signal Channel
(fig. 152)

The tty channel in the receive section of the multiplexer consists of cathode follower V8A, bandpass filters FL3 and FL4, mixer V4, and amplifier V3A.

a. Cathode Follower V8A. The multiplex signal at the wiper arm of R41 is applied to the grid (pin 3) of V8A. Cathode follower V8A matches the high-input impedance of the V8A grid circuit to the low-input impedance of FL4. The output signal is developed across cathode resistor R34 and applied to FL4 through an impedance-matching network consisting of R33 and C24.

b. Bandpass Filter FL4. Filter FL4 rejects all signal frequencies below 4,225 cps and above 4,325 cps. Therefore, only 4,225-cps space and 4,325-cps mark signals appear at the output of the filter. The output of FL4 is applied to mixer V4.

c. Mixer V4. The 4,225- and 4,325-cps tty signals from FL4 are applied to the grid (pin 7) of V4B. The 3-kc injection signal from V3B (para. 19) is applied to the grid (pin 3) of V4A. The two input signals are mixed in the plate circuit to produce sum and difference frequencies across plate load resistor R20. The sum and difference frequencies are applied to FL3 through coupling capacitor C16. Resistor R21 and capacitor C21 form a plate-decoupling network.

d. Bandpass Filter FL3. Filter FL3 is another selective filter. Signal frequencies below 1,225 cps and above 1,325 cps are rejected. Therefore, only the mark (1,325 cps) and space (1,225 cps) signals appear at the output. The output of FL3 is applied to amplifier V3A.

e. Amplifier V3A. The basic design and operation of V3A is the same as that of V5A (para. 15*c*).

(1) The 1,225- and 1,325-cps signals are applied to the grid (pin 3) of V3A. The signals are amplified, developed across plate load resistor R6, and coupled to the primary of T3, through capacitor C10. Transformer T3 matches the high-output impedance of V3A to the 600-ohm output line.

(2) The tty signal is inductively coupled to the secondary of T3. The output signal across the secondary of T3 is applied to test jack J3 and between pins D and E of jack J9. The output of pack J9 is applied to the control panel (para. 159). Capacitors C5 and C6 bypass high-frequency transients.

Section IV. OSCILLATOR SECTION

17. General

The oscillator section produces the 3-kc injection signal which is mixed with the tty signals. The oscillator section consists of two crystal-controlled oscillators, V7A and V7B, and cathode follower V3B. Circuit details of the oscillator are covered in paragraphs 18 and 19.

18. Oscillators V7A and V7B
(fig. 152)

Oscillators V7A and V7B operate at a frequency of approximately 1 mc separated by 3 kc. The crystals are enclosed in a temperature-controlled oven for stability.

a. Oscillator V7A. The frequency of this oscillator is controlled by crystal Y2. Capacitor C44 shunts the crystal so that the output frequency is approximately 1 mc. Feedback voltage is developed in the cathode circuit of V7A across inductor L3. Capacitors C27 and C28 form a capacitive voltage divider. This voltage divider determines the amount of feedback voltage needed to maintain oscillation. Resistor R40 is the dc ground return for the grid.

b. Oscillator V7B. The frequency of this oscillator is controlled by crystal Y1. Trimmer C20 shunts the crystal so that the output frequency of V7B can be adjusted. The remaining components in V7B serve identical functions with the corresponding components in V7A (*a* above).

c. Output Circuit. The outputs of V7A and V7B are mixed in the plate circuit. Sum and difference frequencies are developed across common plate load resistor R31 and coupled to cathode follower V3B, through capacitor C19 and isolation resistor R17.

19. Cathode Follower V3B
(fig. 152)

Cathode follower V3B isolates oscillator circuit V7 from loading effects by the following stages:

a. The sum and difference frequencies generated by V7 (para. 18) are applied to a tuned circuit in the grid circuit of V3B. The tuned circuit, consisting of inductor L1 and capacitor C15, selects the 3-kc difference frequency. All other frequencies are bypassed by the tuned circuit.

b. The 3-kc injection signal is developed across cathode resistor R18. The output is coupled through capacitor C14 to mixers V2 and V4, and to SIGNAL pushbutton S2.

Section V. MULTIPLEXER POWER SUPPLY

20. General

The multiplexer power supply provides all the necessary filament and plate supply voltages for the vacuum tubes associated with the multiplexer. Circuit details are covered in paragraphs 21 through 25.

21. Ac Input Circuit
(fig. 152)

Supply voltage of 120 volts ac, single phase, 400 cps is applied between terminals 1 and 2 of TB2. The supply voltage from TB2 is applied through switch S1 and fuse F1 to the primary of filament transformer T10. The supply voltage from fuse F1 is routed through fuse F2 to transformer T9 and time delay relay K1. Capacitors C42 and C43 are bypass capacitors for high-frequency transients.

22. Transformers T9 and T10

a. Transformer T9. Transformer T9 contains one high-voltage winding and two filament windings. The output between pins 5 and 7, approximately 650 volts ac, is applied to the rectifier circuit (para. 23). The 6.3-volt ac between pins 8 and 9 is the filament supply for regulator tube V10. The 6.3-volt ac output between pins 10 and 11 is the power source for the heating element in crystal oven HR1 and the filament supply for tube V11. Capacitor C41 is a bypass for high-frequency transients.

b. Transformer T10. When power is applied to the primary of transformer T10, filament indicator lamp DS1 is lighted. Resistor R61 limits the amount of current through DS1. The 6.3-volt output of the secondary winding (pins 5 and 7) is the filament supply for tubes V1 through V9.

23. Multiplex Rectifier and Filter Circuits
(fig. 152)

a. Rectifier Circuit. The ac input voltage is rectified by a full-wave rectifier consisting of silicon diodes CR1, CR2, CR3, and CR4. Each pair of diodes conducts on alternate half cycles. Resistors R53 and R56 are surge-limiting resistors. These resistors limit the peak current that can flow through the rectifier during the initial charge of filter input capacitor C38. Resistors R54, R55, R57, and R58 equalize the peak inverse voltage across the rectifiers.

b. Filter Circuit. The pulsating dc output of full-wave rectifiers CR1 through CR4 is filtered and applied to the voltage-regulator circuit

(para. 25). The rectified output is filtered by a pi-section filter consisting of capacitors C37 and C38 and inductor L5. Capacitor C38 offers a low impedance for the ac components, and inductor L5 and capacitor C37 further reduce the pulsations. The output of the filter circuit is applied to series regulator V10 through the closed contacts of time delay relay K1.

24. Time Delay Relay K1
(fig. 152)

The filtered output from the rectifier is applied to the contacts of time delay relay K1. Approximately 30 seconds after power is applied, the contacts of K1 close and plate voltage is applied to the vacuum tubes of the multiplexer. Amber TIME DELAY lamp DS2 is lighted when the contacts of K1 close. Resistor R52 is the current-limiting resistor for lamp DS2.

25. Multiplexer Regulator Circuit
(fig. 152)

The regulator circuit consists of series regulator V10, differential amplifier V11, and voltage regulator V12. Variations in the supply output voltage are sensed in the grid circuit of V11. These variations are amplified by V11 and used to control the bias of V10, which, in turn, controls the supply output voltage.

a. Series Regulator V10. Tube V10 is connected in series with the supply output voltage and serves as a variable resistor. The voltage drop across V10 is determined by the bias applied to the tube. The bias for V10 is controlled by differential amplifier V11 (*b* below). When the bias increases, the voltage drop across V10 increases, which, in turn, decreases the output supply. When the bias decreases, the reverse action occurs. The 200-volt dc supply from the cathode (pin 1) of V10 is applied to the plate circuits of the tubes used in the multiplexer. The output is also applied to B+ indicator DS3, through resistors R43 and R45.

b. Differential Amplifier V11.

(1) Variations in the output voltage are detected and amplified by V11. A reference voltage at the grid (pin 1) of V11 is established by a voltage-divider network consisting of resistors R46 and R47. The cathode potential of V11 is held constant by regulator tube V12 (*c* below). The plate of V11 is connected to the grid (pin 2) of regulator tube V10.

(2) When the output supply voltage increases, one-half of the increase is applied to the grid (pin 1) of V11, which, in turn, decreases the bias applied to V11; this results in an increase in current flow through the tube and plate load resistor R50. The increased current flow through R50 increases the negative bias voltage applied to V10. The series resistance of V10 increases, thereby reducing the output voltage to normal. When the output supply voltage decreases, the bias on V11 increases, which, in turn, decreases the bias on V10; this decreases the series resistance of V10 and, in turn, increases the output voltage to normal.

(3) Capacitor C35 provides a low-impedance path around R46. This improves the regulation when rapid changes occur in the output voltage. When a rapid change occurs, the entire voltage variation is coupled through C35 and applied direct to the grid of V11. Tube V11 immediately applies the corrective action to V10.

c. Voltage Regulator V12. Tube V12 is a gas-type voltage-regulator tube that maintains the cathode of differential amplifier V11 at a fixed potential with respect to ground while the other tube element potentials of V11 are permitted to vary with changes in the output supply voltage. When the output supply voltage decreases, the positive voltage at the control grid of V11 decreases. Since the cathode of V11 is held constant by V12, the plate current of the differential amplifier decreases and the bias on V10 also decreases. When the output supply voltage increases, the opposite action

occurs. Resistors R48 and R49 complete the dc path for V12, and capacitor C36 provides an ac ground for the voltage-regulator tube, thereby preventing oscillations. Resistors R43 and R44 are a bleeder network across the power supply output.

CHAPTER 3

FUNCTIONING OF MODULATOR-MULTIPLIER MD–465/TRC–80

Section I. BLOCK DIAGRAM

26. General

a. Modulator-Multiplier MD–465/TRC–80 (modulator-multiplier) is capable of accepting modulation inputs from an order-wire input circuit and a multiplex input from external multiplex equipment. When the AN/TRC–80 is used as part of the Pershing Weapons System, *no input is applied to the multiplex input circuit.* Multiplexed speech and teletypewriter signals in the 300- to 4,325-cps range are applied to the order-wire input circuit. Phase modulators and frequency multiplier circuits are used in the modulator-multiplier to produce a frequency-modulated output signal at a crystal-controlled center frequency of 70 mc.

b. The function of the modulator-multiplier with respect to the other units of the AN/TRC–80 is covered in paragraph 55*c* of TM 11–5820–469–20.

27. Modulator-Multiplier Signal and Power Circuits

(fig. 153)

Note. When the AN/TRC–80 is used as part of the Pershing Weapons System, the outgoing multiplex signal (originating in the multiplex unit) is always applied to the input of the order-wire modulator.

a. Order-Wire Modulator. The order-wire modulator circuit modulates a local crystal-controlled oscillator signal with the input signal from the multiplexer unit. The 300- to 4,325-cps signal from the multiplexer (para. 12) is applied to phase-splitter transformer T2. Two equal amplitude out-of-phase outputs are obtained from T2. The outputs are applied to phase modulator tubes V2 and V3. A stable crystal-controlled 729.166-kc signal from oscillator V1 is also applied to V2 and V3. The oscillator signal is phase modulated by the input signal. The phase-modulated output signal from V2 and V3, with a center frequency of 729.166 kc, is applied to cathode-coupled limiter V4. The limiter clips amplitude modulations and the center frequency is raised to 2.1875 mc by frequency tripler V4A. The output of V4A is applied to doubler V5, where the center frequency is raised to 4.375 mc and applied to multiplex phase modulator V6 and V7.

b. Multiplex Modulator. When the AN/TRC–80 is not used with the Pershing Weapons System and the multiplex input circuit is used, the outgoing multiplex signals are applied through the emphasis- and frequency-correction network to amplifier V17. The multiplex signal is amplified by V17 and V18A. The amplified output of V18A is applied to phase splitter V18B. Two equal amplitude out-of-phase outputs from V18B are applied to multiplex phase modulator V6 and V7. The 4.375-mc signal applied to V6 and V7 from doubler V5 is phase modulated by the multiplex signal. The 4.375-mc signal carrier output of the multiplex modulator contains phase-modulation components of both the order-wire and multiplex input signals (when both inputs are used). The carrier output signal is applied to frequency doubler V8.

c. Multiplier, Limiter, and Amplifier Stages. The modulated carrier frequency is doubled to 8.75 mc by frequency doubler V8. The output is applied to cathode-coupled limiter V9. Amplitude-modulation components generated by the multiplex phase modulator are removed by limiter V9. The modulated carrier output of V9B is raised to a frequency of 35 mc by frequency doublers V10 and V11. The 35-mc modulated carrier is amplified by V12 and again

doubled in frequency by V13. The 70-mc carrier is further amplified by V14, V15, and V16. The amplified 70-mc carrier is applied to the transmit converter (para. 50).

d. Power Supply. Transistorized power supply A1 supplies plate voltage to all the modulator-multiplier stages. An input voltage of 120 volts ac, single phase, 400 cycles is applied to filament transformer T1 and time delay K1. Time delay K1 permits the filaments to heat for approximately 30 seconds before plate voltage is applied. The output of K1 is applied to a regulated 200-volt dc power supply.

Section II. ORDER-WIRE MODULATOR

28. General

Input signals from combiner amplifier V6 in the multiplexer unit (para. 12) phase-modulate a stable frequency generated by oscillator V1. Amplitude-modulation components are removed and the modulated carrier frequency is multiplied by a factor of 6, which results in a center frequency of 4.375 mc. Circuit details for the order-wire modulator are covered in paragraphs 29 through 33.

29. Crystal Oscillator V1B
(fig. 154)

Crystal Y1 and tube V1B form a crystal-controlled oscillator which develops an output frequency of 729.166 kc.

a. Crystal Y1. Crystal Y1 is housed in a hermetically sealed, temperature-controlled oven assembly that plugs into a standard octal socket. A thermal switch, powered by the ac source voltage, maintains the oven temperature at approximately 60° C.

b. Oscillator Circuit. Crystal Y1 and capacitors C1, C2, and C3 form the tuned circuit for the oscillator. FREQ ADJ capacitor C1 is a trimmer, used to compensate for minor changes in the tuned circuit. Capacitor C2 provides a feedback path for the signal developed across the cathode circuit of V1B to crystal Y1 to sustain oscillations. Resistor R1 is a tank-loading resistor. Cathode bias is developed by resistor R3. Resistor R2 is a parasitic suppressor. The oscillator output developed in the cathode circuit of V1B is applied to cathode follower V1A, through C5.

30. Cathode Follower V1A
(fig. 154)

Cathode follower V1A isolates the oscillator from the phase-modulator stage. This prevents any load variations in the modulator stage input circuit from affecting the oscillator frequency.

a. Circuit Function. The oscillator output is applied to the grid (pin 3) of V1A. The oscillator signal is developed across a resonant circuit consisting of C148, L34, and R5 in the grid circuit of V1A. Resistor R8 and capacitors C6 and C146 are a plate-decoupling network. The output signal developed across cathode resistor R7 is applied to order-wire modulator V2 through C8. The signal to V3 is coupled through C7 and L2.

b. Carrier Switch S2. When switch S2 is pressed, the carrier output of V1A is grounded, removing the carrier signal from the order-wire modulator for adjustment purposes.

31. Order-Wire Modulator
(fig. 1)

The 729.166-kc output of crystal oscillator VI (paras. 29 and 30) is applied to order-wire phase-modulator tubes V2 and V3. This signal is phase modulated by the input signal from combiner amplifier V6 in the multiplex unit (para. 12).

a. Phase Modulation. Phase modulation is the process of varying the phase of a carrier signal according to the instantaneous *amplitude* of the modulating signal. Details of phase modulation are covered in the fundamental series, TM 11–668, and a specific explanation of phase-modulation process by the use of a balanced modulator is covered in paragraph 35 of TM 11–668.

b. Order-Wire Input Circuit. Input signals, in the 300- to 4,325-cps frequency range, from the multiplexer (para. 12) are applied to jack

J8 and, through a 600-ohm T-pad, to transformer T2. The T-pad consists of resistors R15 and R16, and OW DEV control R17. The setting of R17 determines the amplitude of the modulating signal applied to V2 and V3, which in turn, determines the amount of carrier deviation from the center frequency.

(1) *Phase splitter T2.* The input audio signals applied to transformer T2 are inductively coupled to the secondary. The two outputs from pins 3 and 4 and from pins 4 and 5 are equal in amplitude but are 180° out of phase. The signals from T2 are coupled to V2 and V3 through frequency-correction networks (2) below).

(2) *Frequency-correction networks.* To obtain a frequency deviation from a phase-modulator network that depends only on the input signal amplitude and not the input signal frequency, frequency-correction networks are used. The frequency-correction networks are designed to produce approximately 60° of phase shift to the input audio signal and reduces the amplitude of the higher modulating frequencies. This network is made up of resistor R13 and capacitor C9 for the modulation input to V3, and resistor R14 and capacitor C10 for the input to V2. Capacitors C9 and C10 also provide a low-impedance path to ground for the 729.166-kc carrier signal.

c. Phase Modulator V2 and V3.

(1) Both the carrier signal (729.166-kc) and the modulating signal (300 to 4,325 cps) are applied to the grids (pin 1) of V2 and V3. The 729.166-kc carrier signal is applied to V2 through a phase lead network consisting of R10, C8, and C10. The carrier signal applied to V3 is coupled through a phase lag network consisting of L2, R9, C7, and C9.

(2) The modulating signal (*b* above) applied to the control grids of V2 and V3 are 180° apart. Because the plates of these two tubes are connected in parallel, the input carrier signal is effectively cancelled across common plate load R22. The modulating voltage, however, unbalances the modulator tubes, and sidebands produced by the audio and carrier signals appear across the plate load.

(3) The phase-modulated output signal from V2 and V3 is applied through C17 to cathode follower V4. The output is also coupled through capacitor C14 to jack J1, which is used as a test point for checking the gain balance of V2 and V3. The gain of V2 and V3 is equalized by adjustment of OW BAL control R20 in the cathode circuit.

d. Minor Components. The minor components associated with V2 and V3 are listed below.

Component	Function
R11 and R12	Parasitic suppressors.
R18 and R19	Cathode resistors.
C11 and C13	Cathode bypass.
R21	Screen-grid voltage-dropping resistor.
C12	Screen-grid bypass.
L3 and C15	Plate-decoupling network.

32. Cathode-Coupled Limiter Tripler V4 (fig. 154)

a. General. Tube V4B clips both halves of the modulated input signal and thus removes amplitude variations produced by the modulator stage (para. 31). Tube V4A functions as a tripler circuit which raises the center frequency of the modulated signal to 2.1875 mc.

b. Tube V4B. The phase-modulated input signal is applied to the grid (pin 7) of V4B through capacitor C17 and parasitic suppressor R23. The output signal is developed across cathode resistors R26 and R27 and applied to the cathode of V4A. Limiter V4B operates as an overdriven amplifier which, by clipping the peaks of the positive and negatives halves of

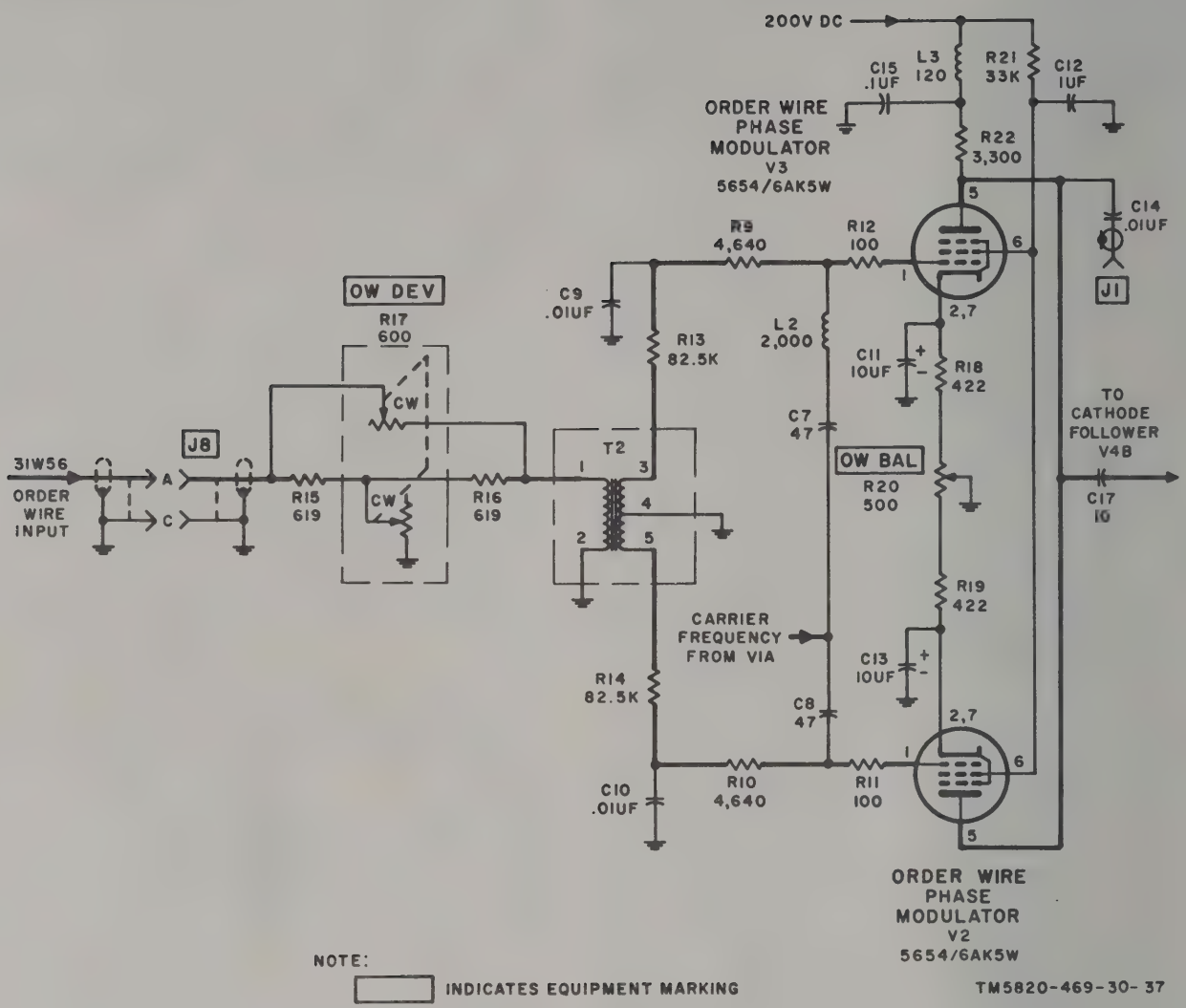


Figure 1. Order-wire modulator, simplified schematic diagram.

the input signal, removes all amplitude variations from the input signal.

c. Tube V4A. The input signal to V4A is developed across the cathode circuit. The control grid is grounded at the carrier frequency by C20. The output is developed across a plate tank circuit consisting of L4, C23, and C24 which is tuned to select the third harmonic (2.1875 mc) of the input signal. (Note that frequency multiplication of the input signal results in the multiplication of the frequency deviation also.) The output of the tripler is coupled to doubler V5 through C22.

d. Minor Components. A voltage divider consisting of R30 and R31 provides a fixed bias for the grids of V4A and V4B. Resistor R25 prevents interaction between the two grids. Plate decoupling for V4B is accomplished by R24 and C18; R28 and C19 perform the same function for V4A.

33. Frequency Doubler V5
(fig. 154)

Frequency doubler V5 doubles the 2.1875-mc input signal to produce an output at 4.375 mc.

a. Input Circuit. The input signal from tripler V4A is developed across a tuned circuit consisting of L5, C26, C25, and R32, and coupled, through parasitic suppressor R33, to the control grid of V5.

b. Output Circuit. The output of V5 is coupled by a double-tuned circuit consisting of L6, L7, C30 through C33, and C36. The double-tuned circuit selects the second harmonic (4.375 mc) of the input signal. The output of the doubler stage is taken from the junction of the capacitive voltage-divider network consisting of C35 and C36 and is applied to amplifiers V6 and V7 of the multiplex phase modulator (para. 38).

c. Minor Components. The functions of the minor components associated with V5 are listed below:

Component	Function
R34	Cathode bias resistor
C27	Cathode bypass
R36	Screen-grid voltage-dropping resistor
C29	Screen-grid bypass
R35 and C28	Plate-decoupling network

Section III. MULTIPLEX MODULATOR

34. General
(fig. 154)

Multiplex input connector J9 is not used when the AN/TRC-80 is part of the Pershing Weapons System. In the Pershing Weapons System, the multiplex signal (300 to 4,325 cps) from the multiplexer unit (paras. 4–25) is normally routed through the order-wire modulator circuits of the modulator-multiplier (paras. 28–33). In other applications (a multiplex signal from 4 to 552 kc may be applied to multiplex input connector J9. (*External multiplex equipment must be used to derive this 4- to 552-kc multiplex signal.*) When the multiplex input facilities of the modulator-multiplier are used, the multiplex input signal is applied to a phase-splitter circuit to obtain two outputs, which are used to modulate a signal with a center frequency of 4.375 mc (para. 33). Circuit details of the multiplex input circuit are covered in paragraphs 35, 36, and 37.

35. Modulator Multiplex Input Circuit
(fig. 154)

The external multiplex input signal is applied to jack J9, coupled through a 75-ohm T-pad, and terminated across 75-ohm resistor R107. The T-pad consists of resistors R104 and R105 and MUX DEV control R106. MUX DEV control R106 adjusts the input level to produce the desired amount of frequency deviation in the output of the modulator-multiplier.

36. Emphasis- and Frequency-Correction Networks
(fig. 2)

To maintain a uniform signal-to-noise ratio in the output of the receiver over a wide band of multiplex modulation frequencies, it is necessary to progressively increase the frequency deviation at the transmitter end for the higher modulation frequencies. This is done by canceling the effects of the frequency-correction network.

a. The input signal terminated across resistor R107 is coupled by capacitor C108 to resistor R108. Parallel resistors R109 and R110 form the resistor portion of the basic frequency-correction network. With switch S3B (S3A is not used) in the 0 MICRO SEC EMPHASIS position, R_A (fig. 2) is 0 ohm and C_A is 1,530 micromicrofarads ($\mu\mu$f) (capacitors C109, C110, and C111 in parallel, fig. 154). This is the capacitive portion of the basic frequency-correction network.

b. The approximate frequency at which the level of the signal to V17 stops following the frequency-correction network characteristic (decreasing proportionally with frequency) is the frequency at which the reactance of capacitor C_A equals the resistance of R_A. Above this frequency, the frequency-correction network becomes effective. As a result, the carrier frequency deviation in the output of the multiplex

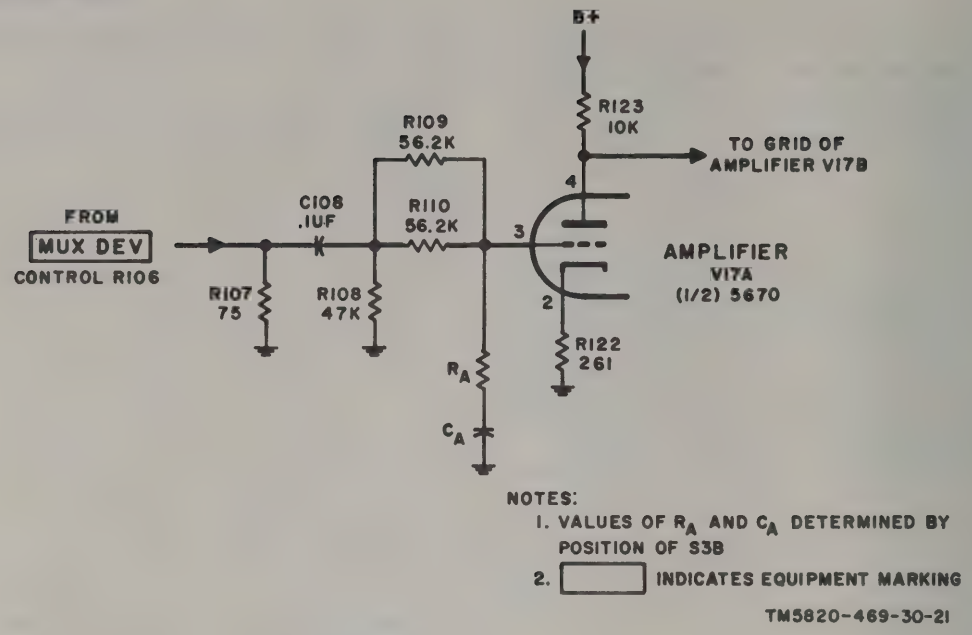


Figure 2. Emphasis- and frequency-correction network, simplified schematic diagram.

phase modulator increases with the frequency of the multiplex modulating signal. The selection of emphasis is determined by the highest multiplex modulating frequency being used.

37. Multiplex Amplifiers V17 and V18A and Phase Splitter V18B
(fig. 154)

The external multiplex signal is amplified by V17A, V17B, and V18A. Tube V18B functions as a phase splitter to provide the two out-of-phase modulating signals to multiplex phase modulator V6 and V7.

a. Amplifier V17A. The multiplex signal from the emphasis network is applied to the control grid of V17A. The amplified signal voltage developed across plate load resistor R123 is applied to V17B, through C116. Resistor R124 and capacitors C114, C143, and C144 form a plate-decoupling network. Resistor R122 and capacitor C115 provide cathode bias.

b. Amplifier V17B. The output of V17A is applied to the control grid of V17B through coupling capacitor C116. The amplified signal voltage developed across plate load resistor R127 is applied to V18A, through capacitor C118. Resistors R125, R129, and R130 make up a broadband feedback voltage-divider network in the output circuit of V17B. Approximately one-half of the output of V17B is fed back out of phase to the input circuit of V17B. This negative feedback stabilizes the gain of the amplifier. Cathode bias for V17B is provided by R126. This resistor is unbypassed to improve the frequency response of this stage.

c. Amplifier V18A. Signal voltages from V17B are applied to the control grid of V18A, through coupling capacitor C118. The amplified signal voltage developed across plate load resistor R133 is applied to phase splitter V18B, through capacitor C120. Resistor R134 and capacitor C119 form a plate-decoupling network. Resistor R132 provides cathode bias for V18A.

d. Phase Splitter V18B. The output of V18A is applied to the control grid of V18B, through coupling capacitor C120. Cathode resistors R136 and R137 form a voltage divider which provides an out-put signal equal in amplitude

to the output signal developed across plate load resistor R139. Capacitors C123 and C124 couple the out-of-phase signals of the phase splitter to balanced amplifiers V6 and V7 of the modulator stage. A feedback network consisting of capacitors C115 and C121 and resistors R122 and R131 is connected between the plate circuit output of V18B and the cathode of V17A. This feedback stabilizes the gain of the amplifier stages and reduces noise and distortion generated within the amplifier stages. Resistor R140 and capacitors C117 and C122 form a plate-decoupling network. Resistor R138 provides cathode bias.

38. Multiplex Modulator V6 and V7 (fig. 154)

a. The 4.375-mc signal (phase modulated by the order-wire signal, para. 31) is applied to V6 through a phase lead network (capacitors C39 and C125 and resistor R43), and to V7 through a phase lag network (inductor L8, capacitors C37 and C126, and resistor R44). Thus, the grids of V6 and V7 are driven at 4.375 mc, 90° apart in phase.

b. The multiplex signal and the phase-modulated 4.375-mc signal are applied to the grids (pin 1) of V6 and V7. The operation of V6 and V7 is the same as that of the order-wire modulator (para. 31*c*) except for input frequencies. The gain of V6 and V7 is equalized by adjustment of MUX BAL control R42 in the cathode circuit. Balance is indicated by a minimum signal measured at jack J2. The output signal is developed across a tuned circuit consisting of capacitors C46 and C47 and inductor L9, and stray capacitance. This tuned circuit is resonant to the multiplex modulator output frequency and provides a resistive load. The phase-modulated signal across the tuned circuit is applied across resistor R47 and coupled through capacitor C145 to doubler V8. When no multiplexer signals are applied, V6 and V7 function as amplifiers for the order-wire phase-modulated signal.

c. The minor components associated with amplifiers V6 and V7 are listed below:

Component	Function
Resistors R38 and R39	Parasitic suppressors.
Resistors R40 and R41	Cathode resistors.
Capacitors C40, C41, C43, and C44	Cathode bypass.
Resistor R45	Screen-grid voltage-dropping resistor.
Capacitor C42	Screen-grid bypass.
Resistor R46 and capacitor C45	Plate-decoupling network.

Section IV. MULTIPLIER, LIMITER, AND AMPLIFIER STAGES

39. General

The phase-modulated 4.375-mc output of multiplex modulator V6 and V7 (para. 38) is amplified and multipled by a factor of 16 by a series of doublers to produce an output center frequency of 70 mc. Circuit details of these stages are covered in paragraphs 40 through 45.

40. Frequency Doubler V8 (fig. 154)

a. Frequency doubler V8 accepts the 4.375-mc input signal and produces an 8.75-mc output signal. The output of modulator V6 and V7 is applied to the grid (pin 1) of V8, through coupling capacitor C145 and parasitic suppressor R48. Grid-leak bias developed by C145 and R49 produces harmonics in the plate circuit of V8. A double-tuned tank circuit consisting of L10, and L11, C52, and C54 is tuned to the second harmonic (8.75 mc) of the input frequency. Resistors R50 and R54 load the tank circuits, reducing the Q of the circuits to provide the required bandwidth for the phase-modulated signal. Capacitor C55 couples the output of V8 to cathode-coupled limiter V9.

b. The doubler stage operates with grid-leak bias and a grounded cathode. Use of grid-leak bias makes the stage self-regulating and thus stabilizes the output level. When the input level to the doubler tends to increase, the grid-leak

bias increases and maintains the output level of the stage relatively constant.

c. Resistor R52 is a screen-grid voltage-dropping resistor. Capacitor C51 is a screen-grid bypass capacitor. Resistor R51 and capacitor C50 provide plate decoupling.

41. Cathode-Coupled Limiter V9 (fig. 154)

Limiter V9 functions as a cathode-coupler limiter which removes any amplitude variations that may be present in the modulated input signal from doubler V8.

a. Limiting Circuit. The output of doubler V8 is applied to the control grid of V9A, through capacitor C55. As the grid of V9A swings positive, the increased current through cathode resistor R57 increases the bias on V9B and cuts V9B off. Since the limiter output is taken at the plate of V9B, the output is limited. As the grid of V9A swings negative, V9A cuts off and, at this point, since there is no further change in the cathode voltage applied to V9B, the output signal is again limited.

b. Output Circuit. The output is developed in the plate circuit of V9B across a double-tuned circuit consisting of L12, L13, C60, C61 and C62 tuned to 8.75 mc. Capacitor C136 couples the output to test jack J3. Capacitor C63 couples the output to doubler V10. Loading resistors R60 and R62 shunt the tank circuits to provide the required bandwidth for the modulated signal.

c. Minor Components. Resistors R58 and R59 form a voltage-divider network which applies a positive voltage to grids of V9A and V9B. Common cathode resistor R57 biases both sections of V9. The grid of V9B is grounded at the signal frequency by capacitors C58 and C59. Resistor R55 and capacitor C56 form a plate-decoupling network for V9A; R61 and C57 perform a similar function for V9B.

42. Frequency-Doubler Stages V10 and V11 (fig. 154)

The 8.75-mc output from cathode-coupled limiter V9 is raised to a frequency of 17.5 mc by stage V10. The 17.5-mc output of doubler V10 is raised to 35 mc by doubler V11. The 35-mc output of V11 is applied to amplifier V12. With the exception of component values (because of different input and output frequencies), doublers V10 and V11 function the same as doubler V8 (para. 40).

43. Amplifier V12 and Frequency Doubler V13 (fig. 154)

The 35-mc input from doubler V11 is amplified by V12 and applied to doubler V13.

a. Amplifier V12 Circuit Function. The 35 mc output of frequency doubler V11 is applied to the control grid of V12, through C75 and parasitic suppressor R75. The input signal is developed across grid resistor R76. The amplified output is developed in the plate circuit across a double-tuned circuit consisting of L18, L19, C79, C80, and C81. This circuit is tuned to a center frequency of 35 mc. The output of this double-tuned circuit is coupled to frequency doubler V13 by C82. Resistors R78 and R81 are loading resistors which reduce the Q of the double-tuned circuit to provide the desired bandwidth for the modulated signal. Amplifier V12 operates with cathode and grid-leak bias. The grid-leak bias is developed by overdriving signals that cause grid current to flow, thereby establishing the output signal level. Resistor R77 and capacitor C78 provide cathode bias for V12. Resistor R80 is the screen-grid voltage-dropping resistor, and capacitor C77 is the screen-grid bypass capacitor. Resistor R79 and capacitor C76 form a plate-decoupling network.

b. Frequency Doubler V13. The 35-mc output from amplifier V12 is raised to a frequency of 70 mc by frequency doubler V13. The 70-mc output of V13 is applied to amplifier V14. With the exception of component values (because of different input and output frequencies) doubler V13 functions the same as doubler V8 (para. 40).

44. Amplifiers V14 and V15 (fig. 154)

Amplifier stages V14 and V15 amplify the

70-mc input signal to the desired signal level for application to V16.

a. Amplifier V14 operates in the same manner as amplifier V12 (para. 43*a*). Amplifier V15 is a cathode-biased class A amplifier stage. The amplified output of V15 is applied to a double-tuned circuit consisting of L24, L25, L26, C98, C99, C100, C101, and C103 tuned to a center frequency of 70 mc. Coupling between the double-tuned circuit is provided by L25. The second tuned circuit is loaded by the input impedance of the cathodes of V16.

b. The remaining components in amplifier stage V15 perform the same functions as similar components in amplifier stage V12 (para. 43*a*).

45. Amplifier V16
(fig. 154)

Amplifier stage V16 amplifies the 70-mc input signal for application to balanced modulator A6 in Amplifier-Converter AM–3303/TRC–80 (para. 54).

a. Amplifier V16 is a grounded-grid amplifier which uses both sections of a type 5670 twin-triode tube. The amplified 70-mc output is developed across a single-tuned circuit consisting of L27, L28, C104, C107, and the output capacitance of both tube sections of V16. By tapping into the tuned circuit between L28 and C107, a low-impedance tap can be obtained. The output is coupled through C105 to output jack J6. Capacitor C106 and resistor R102 couple the 70-mc output to jack J7 for test purposes.

b. Cathode bias is furnished by R100 and C103; R101 and C102 form a plate-decoupling network.

Section V. POWER SUPPLY AND CONTROL CIRCUITS

46. General

The control circuits provide the necessary control for application of operating voltages to the modulator-multiplier. Power supply A1 furnishes a regulated 200-volt dc output to the modulator-multiplier as plate supply and biasing voltage. Details of these circuits are covered in paragraphs 47 and 48.

47. Power Input Circuit
(fig. 154)

Input ac power to the modulator-multiplier is 120 volts, single phase, at a line frequency of 400 cps. Two input connections are provided, one for the filament supply and the other for the B+ supply. During normal operating conditions, the 120-volt, 400-cps power source from the engine generator is connected to terminals 1 and 2 of TB1. Jumpers are connected between terminals 2 and 3 and 1 and 4 of TB1. Line filters consisting of inductors L29 through L32 and capacitors C139 through C142 prevent high-frequency transients, originating in the supply source or other circuits of the AN/TRC–80, from entering the modulator-multiplier by way of the power input line.

a. Filament Supply. With switch S1 in the POWER position, the supply voltage is routed through F1 to the 120-volt tap (terminals 1 and 3) of filament transformer T1, and neon FIL indicator lamp DS1 is lighted. Resistor R146 is a current-limiting resistor for DS1. With switch S1 closed, the supply voltage is also applied to crystal oven assembly Y1 and to the heating element of time delay relay K1. The 6.3 volts at the secondary of T1 is applied to the filaments of tubes V1 through V18 of the modulator-multiplier. The filaments of V8 through V16 are bypassed by capacitors C127 through C135 to prevent interstage radio-frequency (RF) coupling by way of the filament circuits.

b. B+ Supply Input. With switch S1 in the POWER position, the ac line voltage is also applied to the contacts of time delay K1, through fuse F2. Thermal contacts of relay K1 close after 30 seconds, connecting the 120-volt supply to the primary of power transformer T101 in power supply A1. The transistorized power supply requires no warmup time; therefore, B+ indicator lamp DS3 is lighted at the same time that the contacts of

K1 close. Failure of DS3 to light simultaneously with TIME DELAY indicator lamp DS2 inidcates a defective power supply. Resistors R147 and R148 are current-limiting resistors for DS2 and DS3.

48. Power Supply A1, 200-volt (fig. 154)

The transistorized power supply maintains an output voltage within 1 percent of 200 volts, with a 2:1 change in load current with any fixed ac input voltage from 108 to 132 volts and any line frequency from 47 to 420 cps.

a. Rectifier and Filter Circuit. A full-wave bridge rectifier consisting of diodes CR101 and CR104 is connected across the secondary of T101. A choke-input filter consisting of L101, C101, and C102 filters the rectified output of the bridge circuit. Capacitors C103 and C105 bypass sharp voltage transients to ground. Resistor R102 protects the bridge circuit by limiting the surge current when the power supply is first turned on.

b. Differential Amplifier (Q104 and Q105). Transistors Q104 and Q105 are connected in a differential amplifier circuit that compares the base voltages of the two transistors and amplifies the difference between the two voltages.

(1) The bases of the differential amplifier (Q104 and Q105) are both referenced to +19.5 volts. The reference voltage for the base of Q105 is held constant by the regulating action of Zener diodes CR108 and CR109. The base of Q104 is referenced to +19.5 by the action of voltage-divider circuit R110 and R112. When the supply voltage changes, the base voltage of Q105 remains constant. However, since the voltage divider (R110 and R112) is connected across the power supply output, the base of Q104 will sense the change in the supply voltage. This *difference* voltage is applied between the emitter and base of Q104, amplified, developed across R109, and applied as a control voltage to the base of Q103.

(2) Resistor R108 and capacitor C104 stabilize the feedback loop and bypass high-frequency variations to the base of Q104 for corrective action. The selection of R111 is determined at the factory. When the voltage at the base of Q104 is not exactly +19.5 volts, resistor R111 is added to the voltage-divider circuit. The value of R111 is determined by the amount of correction necessary.

c. Amplifiers Q101 and Q103. The change in collector current of Q104 (*b* above) causes a change in the voltage drop across R109. Since R109 is in the base circuit of Q103, this action affects the base-to-emitter voltage of Q103. The proper operating voltage for the emitter of Q103 is maintained by a voltage divider consisting of resistors R106 and R107. The collector of Q103 is held at a constant +8.2 volts by Zener diode CR107. Any change in the collector current of Q103 must be supplied through resistor R103, which also supplies base current for emitter follower Q101. Therefore, any change in current through resistor R103 results in an accompanying change in the base-to-collector bias of Q101.

d. Regulator Q102. A change in the base-to-collector bias of Q101 causes a change in the emitter current of Q101, which alters the base-to-emitter biasing of Q102. Transistor Q102 is the main power-regulating unit and is a series element through which all load current must pass. When the base-to-emitter bias is changed, the effective collector-to-emitter resistance changes to provide the desired regulating action. Zener diode CR105 conducts when the voltage across Q101 exceeds approximately 100 volts. This causes a temporary loss of regulation for higher than normal line surges but it does protect Q101 and Q102 from damage.

e. Output Circuit. The power supply is fused externally by F3 connected across power supply terminals 3 and 4. An overload will cause F3 to open, which will remove the short circuit across series resistor R104. With R104 in series with the load, the power supply voltage drops to a very low value, preventing excessive current through the power supply transistors and damage to circuit components of the stages connected to the power supply.

CHAPTER 4

FUNCTIONING OF AMPLIFIER-CONVERTER AM–3303/TRC–80

Section I. BLOCK DIAGRAM

49. General

a. Amplifier-Converter AM–3303/TRC–80 (transmit converter) accepts two input frequencies to produce the 4.4- to 5.0-kilomegacycle (kmc) signal which is used to drive the power amplifier. An input frequency in the 30- to 34-mc range from the synthesizer is multiplied by a factor of 144 to produce an injection signal in the 4,333- to 4,928-mc range. A 70-mc frequency-modulated (fm) signal from the modulator-multiplier is heterodyned with the injection signal to produce an output (upper sideband) in the 4.4- to 5.0-kmc range.

b. Figure 3 is the block diagram of the transmit converter. The function of the transmit converter with respect to the other units of the AN/TRC–80 is covered in TM 11–5820–469–20.

50. Transmit Converter Block Diagram (fig. 3)

a. Oscillator Unit. With switch S1 set to the EXT position (normal operating position), a stable frequency, in the 30- to 34-mc range, from the synthesizer is applied to buffer amplifier V2. Internal oscillator VI may be used to supply an internal signal when switch S1 is placed in the INT position. However, this facility is not used when the AN/TRC–80 is part of the Pershing Weapons System. The input signal to V2 is amplified and applied to frequency tripler V3 to produce an output in the 90- to 102-mc frequency range. The frequency-tripler output is applied to buffer amplifier V4. The amplified output of V4 is applied to the multiplier unit for further frequency multiplication.

b. Multiplier Unit and Varactor Multiplier. The output from the oscillator unit is applied to the multiplier unit. A multiplying factor of 12 is achieved in the multiplier unit by using two frequency-doubler stages and a frequency-tripler stage. The 90- to 102-mc input to V1 is doubled and a 180- to 205-mc signal is applied to V2 for amplification. The output of V2 is applied to frequency doubler V3. The 360- to 410-mc output of V3 is applied to frequency tripler V4 to produce an output frequency in the 1,082- to 1,232-mc range. The output of the multiplier unit is applied to the varactor multiplier where the input frequency is multiplied by a factor of 4. The 4,330- to 4,928-mc output signal from the varactor multiplier is coupled to the balanced modulator (*c* below).

c. Modulator and Output Circuits. The balanced modulator accepts two input signals. One signal is the unmodulated carrier in the 4,333- to 4,928-mc range from the varactor multiplier. This signal is mixed with a phase-modulated 70-mc signal from the modulator-multiplier. The output of the balanced modulator (a double-sideband, suppressed carrier signal) is applied to a tunable filter which selects the upper sideband. The output of the tunable filter, the the 4.4- to 5.0-kmc range, is amplified by traveling wave tube V9 and coupled through a low-pass filter to the power amplifier.

Note. For short-range (line-of-sight) operation, the output of the transmit converter may be connected through a special waveguide-to-coaxial cable adapter (fig. 3, TM 11–5820–469–10) direct to the antenna. Refer to paragraph 77.1 of TM 11–5820–469–10 for the detailed operating procedure for line-of-sight operation.

d. Power Supply. The power supply pro-

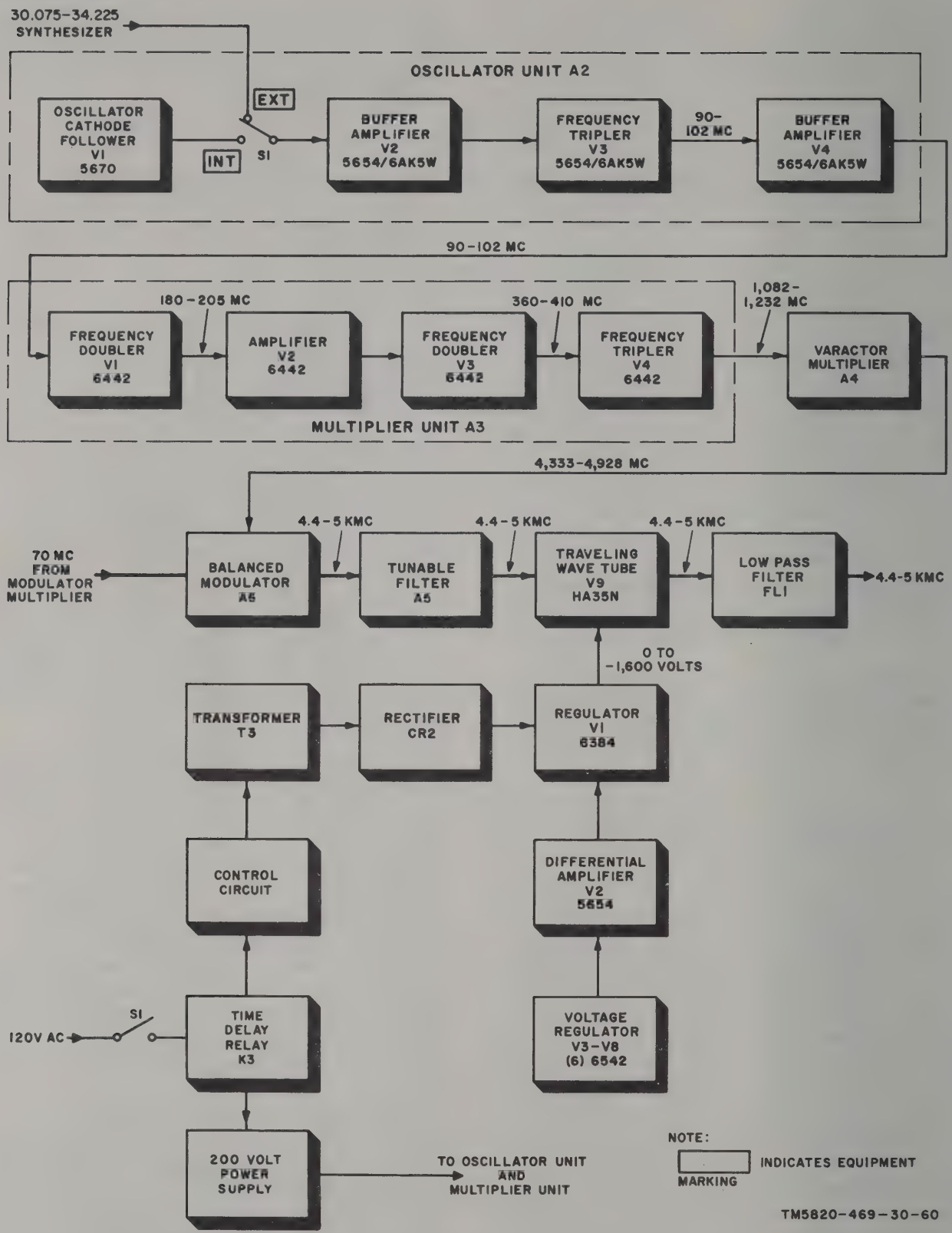


Figure 3. Transmit converter, block diagram.

vides operating potentials to all units of the transmit converter. Primary power of 120 volts ac is applied, through S1 and time delay relay K3, to a +200-volt dc power supply. This +200-volt power supply applies dc voltages to the oscillator and multiplier units. The high-voltage negative dc for the traveling wave tube is supplied by CR2. The rectified output voltage of CR2 is regulated by a regulating circuit consisting of VI through V8.

Section II. CIRCUIT FUNCTION

51. Oscillator Unit (fig. 155)

The oscillator unit consists of tubes VI through V4. This unit accepts the 30.075- to 34.225-mc synthesizer output signal (when S1 is in the EXT position) and multiplies it by a factor of 3 to produce an output frequency in the 90.225- to 102.675-mc range which is applied to the multiplier unit (para. 52).

a. Buffer Amplifier V2. Buffer amplifier V2 isolates the input signal from the loading effects of frequency tripler V3. The synthesizer output at jack J1 is applied across terminating resistor R13, coupled through C14, S1, and parasitic suppressor R15, developed across grid resistor R16, and applied to the grid (pin 1) of buffer amplifier V2. The amplified output signal is developed across a resonant circuit consisting of L3, C2, and C17, and applied to V3. The functions of the minor components are listed below:

Component	Function
R17 and C18	Cathode-bias network
R18 and C16	Plate-decoupling network
R19	Screen-grid voltage-dropping resistor
C19	Screen-grid bypass capacitor

b. Frequency Tripler V3. Frequency tripler V3 multiplies the 30.075- to 34.225-mc signal to produce an output frequency in the 90.225- to 102.675-mc range. The output of V2 is applied to the grid of frequency tripler V3, through parasitic suppressor R20. The grid bias (developed by grid resistor R21) causes tube V3 to produce considerable harmonic distortion in its output. The resonant plate circuit is tuned to select the third harmonic of the input frequency. The 90.225- to 102.675-mc output is applied to buffer amplifier V4. The functions of the other components are listed below:

Component	Function
L4, C3, C21, and C39	Tuned plate tank circuit
R22 and C22	Cathode-bias network
R23 and C20	Plate-decoupling network
R24	Screen-grid voltage-dropping resistor
C23	Screen-grid bypass capacitor

c. Buffer Amplifier V4. Buffer amplifier V4 isolates the tripler amplifier (*b* above) from the loading effects of the multiplier unit (para. 52). The frequency-tripler output is applied to buffer amplifier V4, through parasitic suppressor R25. The output level of the stage is determined by LEVEL ADJUST control R32 (fig. 157) which is connected to the cathode through a filter network consisting of C40, C41, C47, and L11. When the oscillator unit is used as part of the receive converter (para. 86*a*), the gain of V4 is also controlled by an automatic gain control (agc) voltage which is applied to the control grid of V4 through a filter network consisting of R31, C24, and L5. In the transmit converter, R31 is returned to ground (fig. 157). The amplified output of V4 is developed across a resonant circuit consisting of L6 and C4 in the plate circuit of V4. The output is taken off at the junction of a capacitive voltage divider made up of capacitors C28 and C29 and is applied to J2. Capacitors C28 and C29, and resistor R29 match the plate circuit impedance of V4 to a 50-ohm load impedence. The output is also rectified by CR2, filtered by C30, R30, and C50, and applied as a dc voltage to panel meter M1 through pin 14 of plug P1. The functions of the other components are listed below:

Component	Function
R26 and C26	Cathode-bias network.
R27 and C25	Plate-decoupling network.
R28 and C27	Screen-grid voltage-dropping resistor and bypass capacitor.

d. Oscillator-Cathode Follower V1. Crystal-controlled oscillator V1A and cathode follower V1B produce a stable frequency when switch S1 is set to the INT position (synthesizer input not used).

(1) *Oscillator V1A.* The two sections of V1, connected as a ground-grid amplifier (V1A) and cathode follower (V1B), comprise an oscillator circuit where the feedback path to the grounded-grid amplifier section is through the cathode follower stage. Crystal Y1, connected between the two cathodes, functions as a series-resonant circuit which is in series with the feedback path, thereby determining the frequency of the oscillator. The plate circuit of V1A contains a resonant circuit made up of L1, C1, C7, and C8. Resistor R4 lowers the Q of the plate circuit of V1A. The output signal is coupled to cathode follower V1B by C7 and C8. The output is also applied to buffer V2, through C13 and switch S1.

(2) *Cathode follower V1B.* The output of oscillator V1A is applied to the grid of V1B. The cathode follower output developed across cathode resistor R11 is applied as a feedback voltage across cathode resistor R2 of V1A, through C10, Y1, and C9.

(3) *Monitoring circuits.* The voltage across crystal Y1 is rectified by diode CR3 and applied to meter M1, through filter circuit R5 through R10 and C12 and C45. The oscillator output at the plate of V1A is rectified by CR1 and applied to meter M1, through isolating resistor R14 and filter network C15, C31, C49, and L8.

(4) *Minor components.* The functions o the minor components are listed be low:

Component	Function
R1 and C5	Grid-bias network for V1A.
R3 and C6	Plate decoupling for V1A.
R12 and C11	Plate decoupling for V1B.
C42 and C48	Chassis wiring bypass capacitors.

52. Multiplier Unit
(fig. 156)

The 90.225- to 102.675-mc output of the os cillator unit is applied to the multiplier unit The input frequency is multiplied by a facto of 12 to produce an output in the 1,082.7- t 1,232.2-mc frequency range.

a. Frequency Doubler V1. The oscillator uni output is applied to the multiplier unit through J1. The input signal is developed across reson ant circuit L1 and C3. Tapped inductor L provides an impedance match from the 50-ohm line to the cathode of grounded-grid amplifie V1. The second harmonic of the input fre quency is selected by plate-tuned circuit L2 an C6. The output of V1 in the 180.45- to 205.35 mc frequency range is applied to amplifier V through coupling capacitor C7. Resistor R and capacitor C5 form a plate-decoupling net work. Capacitor C2 and resistor R1 provid cathode bias for V1.

b. Amplifier V2. The output of frequenc doubler V1 is applied to the cathode o grounded-grid amplifier V2. The input signa is developed across L4. Cathode bias is fur nished by R3 and C9. The signal voltage at th cathode is coupled through C25 and rectified b diode CR1. The rectified signal is filtered b R4 and C10 and applied to meter M1, through pin 3 of P1. The amplified output develope across the resonant plate circuit consisting o L6 and C14 is applied to frequency doubler V3 through coupling capacitor C15. Resistor R and capacitor C13 form a plate-decoupling cir cuit for amplifier V2. Capacitor C11 provide additional filtering for the B+ line.

c. Frequency Doubler V3. Frequency-doubler stage V3 doubles the input frequency to produce an output in the 360.9- to 410.7-mc range. The input signal to the cathode of grounded-grid amplifier V3 is developed across L7. Inductor L9 and capacitor C22 comprise a tuned plate tank circuit that selects the second harmonic of the input frequency. The output signal is applied to frequency tripler V4 through coupling capacitor C23. Cathode bias for the stage is developed by R6 and C17. The bias voltage developed across R6 is applied to meter M1 through isolating resistor R7 and P1 for monitoring the cathode current of V3. Inductor L10 and capacitors C19 and C21 form a plate-decoupling network.

d. Frequency Tripler V4. Frequency-tripler stage V4 triples the input frequency to produce an output in the 1.082- to 1,232-mc frequency range.

(1) The input signal to the cathode-grid frequency tripler V4 is developed across L13. The third harmonic of the input frequency is selected at the output of V4 by quarter-wavelength coaxial resonator Z1. The resonant frequency is obtained by adjusting a control (marked F), located at the end of the cavity, which varies the cavity length. The energy, coupled from Z1 by a capacitive probe, as applied to the varactor multiplier (para. 53), through jack J2. Another capacitive probe couples the signal at the plate, through a rectifier and filter network consisting of CR2, R10, and the reactive elements of F11, to meter M1 for metering purposes.

(2) Cathode bias for V4 is furnished by R8 and C24. Bias voltage across R8 is applied through isolating resistor R9 to meter M1 through P1 for monitoring cathode current. Filter FL3 in the plate circuit is a plate-decoupling network.

53. Varactor Multiplier V4
(fig. 157)

The varactor multiplier assembly multiplies the input frequency by a factor of 4 to produce an output signal in the 4,330.8- to 4,928.4-mc range.

a. General. The varactor multiplier is a solid-state harmonic generator which consists of two tunable cavities (input and output) and a variable capacitance semiconductor that distorts the input signal to produce an output rich in harmonic energy. The physical size of each cavity may be varied by external controls.

b. Input Circuit. The input signal, in the 1,082.7- to 1,232.1-mc range, is applied, through J1 and a capacitance probe, to the input cavity. The frequenecy (physical size) of this cavity may be tuned by control G.

c. Harmonic Generator. The input signal is coupled from the input cavity, through CR1. The diode output contains many harmonics of the fundamental frequency. Since the output cavity is tuned (by control H) to the fourth harmonic of the input, an output signal in the range of 4,330.8- to 4,928.4-mc is selected and coupled, through J2, P12, and P13, to external RF detector assembly CR5. Diode CR1 (in the varactor multiplier) is self-biased by R1. This self-bias circuit tends to accommodate wide variations in the input power. Resistor R2 and capacitor C1 in the varactor multiplier assembly filter the rectified voltage and couple the rectified output, through FL1 and J8, for metering purposes.

d. Output Circuit. The varactor multiplier 4,330.8- to 4,928.4-mc output signal is coupled through rf detector assembly CR5 to balanced modulator A6 (para. 54). A rectifier and filter network in the detector assembly, consisting of CR1, C1, and R1, applies the rectified voltage to meter M1, through variable resistor R37.

54. Balanced Modulator A6 and Tunable Filter A5
(fig. 157)

Two input signals are applied to the balanced modulator. The balanced modulator produces two sideband signals (upper and lower) and cancels out the carrier frequency. Tunable filter A5 rejects the lower sideband signal and

passes the upper sideband to traveling wave tube V9.

a. The balanced modulator is a solid-state device that heterodynes two input signals. One signal is the frequency modulated 70-mc signal from the modulator-multiplier (para. 45), which is applied to the balanced modulator through FL2. Low-pass filter FL2 prevents any harmonics of the 70-mc signal from being applied to the balanced modulator. The carrier signal from the varactor multiplier (para. 53), in the 4,330.8- to 4,928.4-mc frequency range, is mixed with the 70-mc signal in the balanced modulator. The resulting sidebands are applied to the tunable filter. The carrier signal is balanced out by the modulator circuit. Details of balanced modulator theory are explained in paragraph 28 of the fundamental series TM 11–685.

b. The upper and lower sideband output signals of the balanced modulator are applied to the input of the tunable filter. Tunable filter A5 selects the *upper sideband,* and an output signal in the 4.4- to 5.0-kmc frequency range is applied to traveling wave tube V9 (para. 55) for additional amplification.

55. Traveling Wave Tube V9
(fig. 157)

Traveling wave tube V9 amplifies the 4.4- to 5.0-kmc signal to the level required to drive power klystron tube V201 in the power amplifier (para. 57).

a. Tube V9 consists of a cathode, anode, helix, collector, and input and output coupling loops. The helix consists of a transmission line which is wound in the form of a screw thread. The cathode operates at a high negative potential (—1,600 volts dc) while the collector is maintained at ground potential. The velocity of the electron stream emitted from the cathode is controlled by the anode potential.

b. The input signal from tunable filter A5 (para. 54) is applied to V9, through P17 and the input loop. This signal is inductively coupled to the helix and controls the instantaneous variations of the electron stream as it moves through the helix toward the anode. As the electron stream passes through the length of the helix, the electrons impart energy to the helix. The amplified signal voltage along the helix is coupled to the output loop and applied to low-pass filter FL1. The collector is grounded and completes the dc electron path back to the power supply.

c. The amplified output of V9 is coupled, through low-pass filter FL1 and a detector, to jack J7, and applied to the power amplifier unit. The low-pass filter removes spurious harmonics. A small amount of the RF output signal is rectified by detector diode CR1 and is applied to meter M1, through R36.

56. Transmit Converter Power Supply
(fig. 157)

The operating voltages for the oscillator unit, the multiplier, and traveling wave tube V9 are furnished by the power supplies located in the transmit converter chassis. Circuit details of these power supplies are covered in *a* through *c* below.

a. Input Circuit. The ac input power to the transmit converter is 120 volts, single phase, at a line frequency of 400 cps. The input is applied between terminals 1 and 2 of TB1. Jumpers are connected between terminals 1 and 3, and 2 and 4. When switch S1 is set to ON, 120 volts ac is applied, through fuse F1, to the heating element of time delay relay K3 (3-minute delay) and filament transformers T1 and T2. The secondary of T1 supplies filament voltages to tubes V1 and V2 and to the tubes in the oscillator and multiplier units. The secondary of transformer T2 supplies filament voltage to traveling wave tube V9.

b. Power Supply A1. The 120-volt ac input is applied to power supply A1, through switch S1, fuse F3, and the contacts of time delay relay K3. Power supply A1 furnishes an output of 200 volts dc, which is applied to the oscillator and multiplier units. The 200-volt power supply is identical with the power supply used with the modulator-multiplier. Refer to paragraph 48 for the detailed circuit function.

c. Power Supply for V9. The 120-volt ac input is applied, through switch S1, fuse F3

contacts of time delay relay K3, interlocks S3 and S5, deenergized contacts of overcurrent relay K2, and PUSH TO START switch S2, to the primary of power transformer T3. The output at the secondary of T3 is rectified by CR2 (a four-section metallic rectifier arranged in a bridge circuit configuration) to produce—1,600 volts. This voltage is used to provide the anode potential for V9.

(1) The rectified output voltage of CR2 is filtered by R6 and C2 and regulated by V1. The output voltage of the power supply is controlled by the series resistance of V1, which, in turn, is controlled by differential amplifier V2.

(2) The control grid of V2 is held constant by voltage regulator V3. Resistors R17 through R24 are voltage-dropping resistors in series with V3. The cathode of V2 is returned to a tap on potentiometer R11. Potentiometer R11 controls the collector-to-cathode potential of V9. Any change in the output voltage is reflected across R11 and sensed by the cathode of V2. This action changes the plate current through V2 and, in turn, the voltage drop across R7. Since R7 is in the cathode circuit of regulator V1, the bias on V1 is changed to offset the original change reflected across R11.

(3) Screen-grid voltage for V1 is obtained from rectifier CR3. The voltage developed across secondary winding 7–8 of T3 is rectified by CR3 and filtered by C3 and R15. The output is developed across R16 and applied to the screen grid of V1.

(4) Anode voltage for V9 is determined by the setting of potentiometer R25. This adjustment controls beam focus. Voltage regulators V4 through V8 regulate the voltage across R25.

d. Control Circuits. When PUSH TO START switch S2 is momentarily depressed, 120 volts ac is rectified by diode CR1 and applied to the coil of relay K1. Holding contacts of relay K1 close, thereby holding K1 energized. The other set of K1 contacts opens, removing the short circuit across the anode and cathode of V9. The coil winding of overcurrent relay K2 is connected in series with the helix. When excessive helix current flows, relay K2 energizes. The contacts of K2 open, removing the 120-volt supply to power transformer T3 and relay K1, which, in turn, removes the input power from T3. Potentiometer R26 is used to adjust the level at which overcurrent relay K2 energizes.

CHAPTER 5

FUNCTIONING OF AMPLIFIER, RADIO FREQUENCY AM–3308/TRC–80

Section I. BLOCK DIAGRAM

57. General

Amplifier, Radio Frequency AM–3308/TRC–80 (power amplifier) accepts a frequency-modulated signal in the 4.4- to 5.0-kmc frequeny range from traveling wave tube V9 (para. 55), in the transmit converter, and amplifies the input signal to an output power level of 1 kilowatt. The amplification is accomplished by a four-cavity, air-cooled klystron tube. Figure 158 illustrates the block diagram of the power amplifier.

58. Klystron Unit (fig. 158)

a. Input Circuit. The 4.4- to 5.0-kmc input signal from the transmit converter is applied to the klystron unit through attenuator AT201 and input directional coupler DC201. Attenuator AT201 permits adjustment of the input drive signal to the proper level. Directional coupler DC201 permits monitoring of the input incident and reflected power by use of meter M101 located in the control panel. The output of DC201 is coupled to the input of klystron amplifier V201.

b. Output Circuit. The RF output of the klystron is routed through low-pass filter FL201, directional coupler DC202, and through a waveguide, to the antenna. Harmonics produced in the klystron unit are attenuated by the low-pass filter. Directional coupler DC202 permits monitoring of the output incident and reflected power.

59. Power Amplifier Control Panel (fig. 158)

The power amplifier (pa) control panel contains the control, monitoring, and protective circuits required for proper sequencing of the voltages applied to the klystron. The pa control panel chassis also includes a low-voltage power supply which provides the filament and B+ requirements for all the tubes in the control unit.

a. Chopper Circuit. The rectified samples of the reflected and incident output power from directional coupler DC202 are applied to a chopper circuit. These low-level dc signals are mixed with an ac voltage and converted to ac signals. Two output signals are obtained from the chopper circuit and applied to relay amplifiers V101A and V101B.

b. Reflected Power Monitoring Circuit. The reflected power output control signal from the chopper circuit is amplified by relay amplifiers V101A and V1013A. The output of V103A is applied to cathode follower V102A and relay control V103B. Under normal operating conditions, the V103B is conducting, keeping reflected alarm relay K102 energized. When the reflected power exceeds a predetermined level, current flow through relay control V103B is reduced, which deenergizes relay K102 and thereby activates alarm DS106. The output of cathode follower V102A is applied to relay control V102B. Under normal operating conditions, relay control V102B is conducting, keeping relay K101 energized. When the reflected power exceeds a preset value, current flow through relay control V102B is reduced and relay K101, is deenergized. Deenergizing relay K101 opens the holding circuit for beam-holding relay K106, causing the relay to deenergize. Deenergizing of relay K106 causes beam relay K302 (in the klystron power supply) to remove beam voltage from the klystron unit.

c. Incident Power Monitoring Circuit. The incident power output control signal from the chopper circuit is amplified by relay amplifiers V101B and V104A and applied to relay control tube V104B. When the incident output power drops below a preset value, V104B conducts heavily; this energizes relay K103, which, in turn, activates alarm DS106.

d. Pa Control Panel Power Supply. Single-phase, 400-cps, 120-volt ac input power is applied to transformers T102 and T101. Transformer T102 is a variable transformer which permits adjustment of the filament voltage that is applied, through T302, to klystron tube V201. Transformer T101 supplies the requirements of the filament and B+ circuits. The ac input is rectified by CR115 through CR118 and applied to voltage regulator V105. The regulated dc output voltage is routed to all the tubes within the pa control panel.

60. Klystron Unit Power Supply
(fig. 158)

The klystron unit power supply circuits include a filament supply and a high-voltage beam supply for the klystron tube.

a. Input Circuit. Input source of 208 volts, three-phase, 400 cps, from the engine generator is applied to MAIN circuit breaker CB301. When CB301 is closed, power is applied to BEAM circuit breaker CB302 and BLOWER power switch CB303. The output of CB303 is applied, through a relay, to blower motor B1.

b. Beam Power. When BEAM circuit breaker CB302 is closed, power is applied through beam relay K302 to BEAM VOLTAGE selector switch S302. Switch S302 selects different taps on the primary of transformer T301, varying the beam-voltage power supply output from 5,900 volts to 7,700 volts. The output of T301 is applied to a full-wave bridge rectifier consisting of CR303 through CR308. The negative dc output of the rectifier is applied to the cathode circuit of klystron V201.

c. Filament Voltage. Filament voltage for the klystron is supplied from klystron filament transformer T302. The ac input to T302 is applied through adjustable transformer T102, located in the control panel chassis. The filament voltage is monitored at the primary side of T302 but the meter scale is calibrated to indicate the klystron filament voltage on the secondary winding.

Section II. KLYSTRON DRAWER

61. General

The klystron drawer is composed of an input attenuator and input and output directional couplers, a low-pass filter, and klystron tube type VA–834B. The klystron is a four-cavity, air-cooled, integral-cavity tube capable of tuning the entire frequency range of 4.4 kmc to 5.0 kmc. Tuning is accomplished by means of mechanical linkages through a vacuum seal in the tube. The klystron cavities may be tuned synchronously for maximum gain and minimum bandwidth, or may be stagger tuned to achieve a wider bandwidth at a reduced power gain.

62. Input Circuit
(fig. 159)

The 4.4- to 5.0-kmc output from traveling wave tube V9 in the transmit converter (para. 55) is applied, through the coaxial cable, to attenuator AT201 and directional coupler DC201. From DC201, the input signal is coupled through coaxial cable-to-waveguide adapter CP201 to the input probe on the klystron.

a. Attenuator AT 201. Attenuator AT201 is a resistive element which determines the amount of input signal drive that is applied to the klystron. Attenuator AT201 is adjusted for an input signal drive power of 20 to 100 milliwatts (indicated on POWER IN meter M101).

b. Directional Coupler DC201. The output from attenuator AT201 is cabled to DC201. Two dc outputs from DC201 are applied, through switch S104, to POWER IN meter M101. One output is a sample of the incident input power. This sample voltage is coupled, through J204, to pin 11 of S104. The path to

ground is completed through pin 10 of S104 (when S104 is in the INCIDENT position) and meter M101. Resistor R144 completes the path to ground for the unmetered circuit. The other output from DC201 is a sample of the reflected input power. This sample is applied to meter M101, through J205 and pins 5 and 3 of S1 (when S104 is in the REFLECTED position).

63. Klystron V201
(figs. 4 and 159)

The klystron tube receives an input signal of 20 to 100 milliwatts and raises the signal to an output level of approximately 1,000 watts.

a. A potential of approximately 7,500 volts dc is applied between the cathode and collector of the klystron. The collector of the tube is operated at ground potential, and the cathode is maintained at —7,500 volts. Electrons are emitted from the cathode and accelerated toward the collector by the high dc potential. As electrons move toward the first drift tube section, they are influenced by the magnetic field of the permanent magnet and are focused into a narrow, uniform beam directed through the center of the drift tube. Under normal conditions, 95 to 98 percent of the electrons emitted by the cathode are directed through the drift tube and strike the collector; the remaining 2 to 5 percent strike the body of the tube.

b. When drive power is applied to the tuned resonant input cavity of the klystron, a magnetic field is produced within the first cavity. A time-varying magnetic field always has a time-varying electric field associated with it. The electric field is oriented with respect to the electron beam so that it alternately adds to or subtracts from the applied beam potential. Electrons passing through the first cavity gap at the instant the electric field is additive have

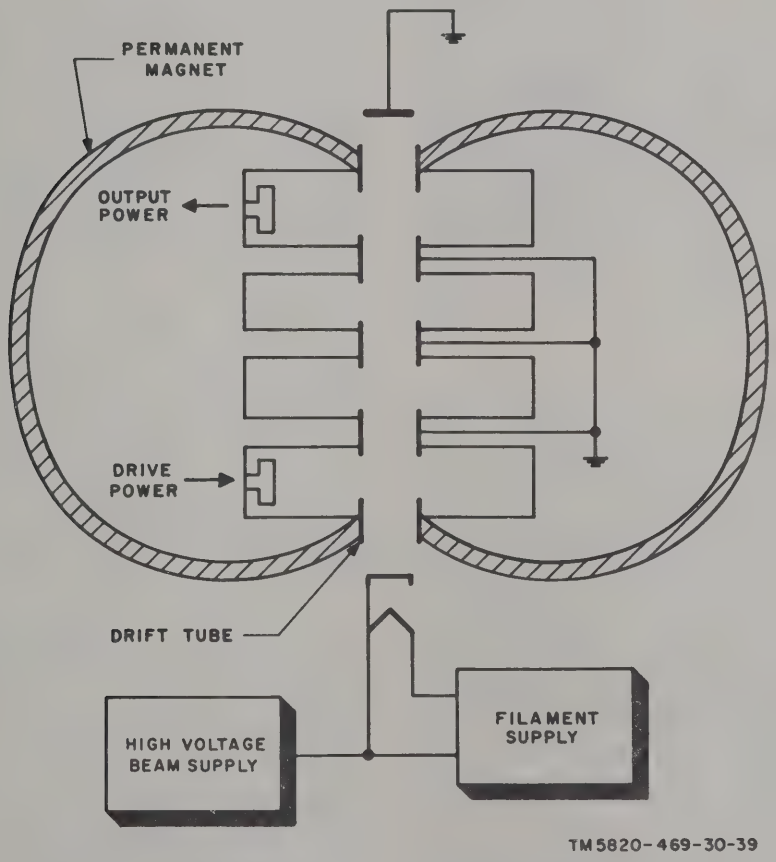


Figure 4. Four-cavity klystron, simplified schematic diagram.

their velocities increased; electrons passing the gap during times when the electric field is subtracting from the beam potential have their velocities decreased. This action tends to bunch the electrons at intervals corresponding to the input frequency.

c. As the partially bunched beam enters the second tuned klystron cavity, magnetic and electric fields are developed within the resonant cavity. The magnetic and electric fields act upon the electron beam to produce more perfect bunching in the draft space between cavities 2 and 3. Tuned cavity 3 completes the bunching by the same process. The output cavity (cavity 4) of klystron V201 is excited by the electron beam in the same manner as cavities 2 and 3, except that its placement with respect to cavity 3 is such that the electric field is produced in the outright cavity decreases the velocity of the electron bunches. This action is equivalent to the cavity absorbing power from the bunched electron beam. A coupling loop inserted in the output cavity couples the absorbed power from the cavity to low-pass filter FL201.

64. Klystron Output Circuit
(fig. 159)

The output power from the klystron coupling loop is fed, through FL201, directional coupler DC202, and a waveguide, to the antenna feed-horn. Filter FL201 is a low-pass filter which passes the resonant frequency and attenuates harmonics produced by the klystron tube. Directional coupler DC202 provides two outputs —One output is a sample of the incident or radiated output power, and the other output samples the reflected output power. Both samples are applied to POWER OUT meter M102 and control circuits located in the pa control panel (para. 59*b* and *c*).

Section III. KLYSTRON POWER SUPPLY

65. General

The klystron power supply contains the high-voltage beam supply, klystron filament supply, circuit breakers, and associated control circuits. The high-voltage beam supply furnishes up to 7,700 volts dc at 0.65 ampere to operate klystron V201. The circuit functions are covered in paragraphs 66 and 67.

66. Klystron Power Input Circuit
(fig. 159)

The engine-generator output of 208 volts, three-phase, 400 cps, is applied to MAIN circuit breaker CB301. When CB301 is in the ON position, power is applied to BLOWER circuit breaker CB303 and BEAM circuit breaker CB302. Single-phase power is applied to FILAMENT switch S101 from circuit breaker CB301, through pin 2 of P304, pin 3 of J101, and fuse F101. The single-phase power is also routed through various interlocks and control relays in the control panel chassis. These control circuits are covered in paragraphs 68, 69, and 70.

a. Blower Motor Power. When BLOWER circuit breaker CB303 is placed in the ON position, power is applied to contacts L1, L2, and L3 of relay K301. When FILAMENT switch S101, located on the pa control panel, is placed in the ON position, 120 volts ac is applied to half-wave recifier CR301. The output of CR301 energizes relay K301, which, in turn, applies power to blower motor B1. Capacitor CB301 provides a bypass for ripple frequencies.

b. High-Voltage Power Supply. When BEAM circuit breaker CB302 is in the ON position, power is applied to the contacts of beam relay K302. When voltage from the pa control panel circuit (para. 59) is applied to half-wave rectifier CR302, the rectifier output energizes relay K301, which, in turn, applies three-phase power to BEAM VOLTAGE selector switch S302 and transformer T301.

c. BEAM VOLTAGE Selector Switch and Transformer T301. The three-phase output of transformer T301 is controlled by six-position step switch S302. BEAM VOLTAGE selector switch S302 varies the output range of the high-voltage beam supply from 5,900 volts to 7,700 volts. The three-phase output of transformer T301 is applied to a full-wave rectifier bridge circuit.

67. Rectifier and Filter Circuit
(fig. 159)

The rectifier and filter circuit provides a 5,900- to 7,500-volt dc output which provides beam potential for klystron tube V201.

a. Rectifier. Six silicon power rectifiers, CR303 through CR308, are arranged in a three-phase, full-wave, bridge rectifier circuit. Capacitors C304 through C309, connected across the input of the bridge circuit, reduce damaging transient voltages induced by the switching action of the circuit.

b. Filter. The rectified output of the bridge rectifier circuit is applied to a choke-input filter consisting of L301 and C303. The positive side of the output, operating near ground potential, is connected to the body of klystron V201 (collector). The negative side (—7,500 volts dc with respect to ground) is connected to the klystron cathode. When the power supply is removed from the cabinet, shorting switch S301 connects both sides of the output circuit to ground and discharges filter capacitor C3. Resistors R306 through R315 comprise a bleeder network across the output of the rectifier.

Section IV. CONTROL CIRCUITS

68. General

Three-phase, 208-volt, 400-cps power is connected to the power amplifier through cabinet jack J1. The three-phase input is used to provide the high voltage required for the beam potential for V201 (paras. 66 and 67). A single-phase, 120-volt ac source is used as the filament and control voltage for the power amplifier. The power-on sequence of the power amplifier is controlled by the 120-volt ac input that is obtained from terminals A (neutral) and D of jack J1 (fig. 159). Paragraphs 69 and 70 describe the function of the power-on sequence.

69. Power-On Sequence, Phase 1
(figs. 159 and 160)

The chart below lists the sequence of operations that occurs as the various circuit breakers and relays are energized. The components that cause a sequence of operations to occur are listed horizontally, from left to right. The resulting sequence of operations is listed vertically, directly under the component that has caused the operation. Use the functional diagram, figure 160, and the complete schematic diagram, figure 159, in conjunction with the text.

a. Initial Phase.

Sequence No.	MAIN circuit breaker CB301	BEAM circuit breaker CB302	BLOWER circuit breaker CB303	FILAMENT switch S101
1	Turned on	Turned on	Turned on	Turned on.
2	208 v, 3Ø ac applied to CB302 and CB303. Single-phase, 110 v ac applied to FILAMENT switch S101.	208 v, 3Ø ac applied to contacts L1, L2, and L3 of K302.	208 v, 3Ø ac applied to contacts L1, L2, and L3 of K301.	120 v ac applied to T101 through L102.
3				120 v ac applied across CR301. CR301 rectifies ac input. Dc applied to blower relay K301.
4				Blower B1 operates and activates air interlock S201.

b. Sequence Following Activation of Air Interlock S201.

Sequence No.	Air interlock S201	Filament interlock K104	Time delay relay K105
1	Activated when blower B1 operates.	Energized when air interlock S201 is closed.	Energized when contacts 8 and 9 of K104 close.
2	110 v ac applied to T102 through F102. Output of T102 applied to kylstron filament transformer T302.	Contacts 2 and 3 of K104 close. This action reduces current through K104 winding (R141 shunts CR120 and K104) and insures that K104 deenergizes when line voltage decreases to level that could result in damage to klystron.	110 v ac applied to TIME DELAY indicator DS102, through closed contacts of K104 and K105.
3	CR113 rectifies 110 v ac input. Energizes filament interlock K104 through filament adjust potentiometer R142. (Diode CR119 protects winding of K104 against counter emf). 110 v ac applied to FILAMENT VOLTAGE meter M103 through voltage divider R302, R303, and R304. Resistor R303 permits calibration of meter M103.	Contacts 8 and 9 of K104 close. 110 v ac applied to FILAMENT hour meter M301, FILAMENT indicator DS101, and winding of time delay relay K105; delay permits 3-minute warmup for V101 through V104 in control panel and klystron V201.	Time delay relay K105 activates power supply (CR115 through CR118) which supplies dc potential for vacuum tube that energizes K101, K102, and K103. Vacuum-tube-controlled relays K101, K102, and K103 are energized. First phase of power-on sequence is completed. No further action occurs until beam ON switch S103 is depressed (para. 70).

70. Power-On Sequence, Phase 2 (fig. 160)

The first phase of the power-on sequence is completed when vacuum-tube-controlled relays K101, K102, and K103 are energized (para. 69*b*, sequence 3 of time delay relay K105). The charts below list the sequence of operations in the same manner as for the phase 1 power-on sequence. Refer to figure 160 for the functional schematic diagram of the power control circuits. The second phase is initiated when beam ON switch S103 is momentarily depressed.

a. Beam ON Switch S103 Sequence.

Sequence No.	Beam ON switch S103	Beam-holding relay K106	Beam recycle relay K107
1	Depressed momentarily.	Energized when beam ON switch is depressed.	Energized when contacts 1 and 2 of K106 close.
2	Line voltage applied to beam-holding relay K106 through beam OFF switch S102, contacts of drawer interlock S303, contacts 2 and 4 of energized K101 (or through normally closed contacts 6 and 8 of K108), contacts 6 and 7 of relay K104, contacts of beam ON switch S103, and through normally closed contacts 3 and 4 of K107 or normally closed contacts 6 and 7 of klystron overcurrent relay K303.	Beam-holding relay K106 is held energized through holding contacts 5 and 6 (which shunt beam ON switch S103).	Line voltage is applied, through energized contacts 6 and 8 of K107 to winding of relay K108, BEAM hour meter M302, BEAM indicator DS105, and diode CR302, to beam relay K302.

Sequence No.	Beam ON switch S103	Beam-holding relay K106	Beam recycle relay K107
		Closed contacts 1 and 2 of K106 apply line voltage to winding of K107 through normally closed contacts 2 and 4 of K108, diode CR114, and R143. Capacitor C114 delays activation of K107 by approximately 0.7 second. Diode CR114 rectifies ac input to provide dc voltage for operation of beam recycle relay K107.	

b. Sequence Following Activation of Relay K108.

Sequence No.	Beam auxiliary relay K108	Alarm auxiliary relay K109	Alarm circuit
1	Activated when contacts 6 and 8 of K107 close.	Activated when contacts 1 and 2 of K108 close.	Klystron alarm circuit is connected across line through contacts 5 and 6 of K109, and contacts 2 and 4 of K103 or contacts 3 and 4 of K102.
2	Contact 2 (of K108) transfers from 4 to 1, thereby releasing K107.	Contacts 2 of K109 transfers from 4 to 1, thereby providing holding circuit for K109 through beam OFF switch S102.	*Note.* Contacts 3 and 4 of K102 and contacts 2 and 4 of K103 are open until monitoring circuits in pa control panel (para. 71) sense abnormal condition. When either K102 or K103 is activated, alarm circuit, is activated.
3	Holding circuit for K302 and K108 is maintained through contacts 2 and 3 of unenergized klystron overcurrent relay K303 and closed contacts of energized relays K104, K105, and K106. (Holding circuit is required because contacts 6 and 8 of K107 open when K107 is deenergized.) The 0.7-second delay introduced by C114 (sequence 3 in *a* above) insures that holding circuit is closed before contacts 6 and 8 of K107 open.		With S105 at OPERATE, ALARM indicator DS106 lights and buzzer DS301 activates. With S105 at TUNE, only indicator DS106 is affected.
4	Line voltage is applied to coil of K109 through contacts 1 and 2 of K108, thereby activating K109.		

71. Klystron Monitoring Circuits (fig. 160)

Note. The klystron alarm circuits are activated only by RF failure, not by high-voltage or interlock failure.

a. Normal Condition.

(1) With klystron V201 properly tuned and the equipment in normal operation, reflected power is low and reflected-off relay K101 remains energized, and contacts 2 and 4 (of K101) provide a holding circuit for beam-holding relay K106 through the closed contacts of beam ON switch S103. (Contacts 6 and 8 of K108 are open during normal operation.)

(2) Reflected power alarm relay K102 is also energized during normal operation, and, as a result, contacts 3 and 4 (of K102) are held open.

(3) Contacts 2 and 4 of unenergized direct alarm relay K103 are open during normal operation, so that the alarm circuit buzzer and indicator circuits are open-circuited in either the TUNE or OPERATE position of S105.

b. Alarm Condition.

(1) Under conditions of reflected power exceeding a preset value (K102 is deenergized) or reduced incident power (K103 is deenergized, the alarm circuits, DS106 and DS301, are activated through closed contacts of K102 or K103 and closed contacts of K109.

(2) If the reflected power exceeds a preset value beyond which the klystron could be damaged, reflected-off relay K101 is deenergized and contacts 2 and 4 (of K101) open, and beam-holding relay K106 is released.

(3) Beam relay K302 and beam auxiliary relay K108 also release, since the holding circuit through contacts 1 and 2 of K106 is broken. Reflected power alarm relay K102 also releases, and contacts 3 and 4 close, thereby activating the RF alarm circuits.

72. Overload Recycling Sequence (fig. 160)

a. Beam-holding relay K106, beam auxiliary relay K108, and beam relay K302 are all energized through normally closed contacts of beam current overload relay K303. (The relay winding of K303 is illustrated in figure 159.) When a momentary overload occurs, the following action takes place:

(1) Overload relay K303 energizes, thereby breaking contacts 2 and 3, and 6 and 7.

(2) When contacts 2 and 3 of K303 open, relays K108 and K302 become deenergized. Open contacts 6 and 7 of K303 release beam-holding relay K106.

(3) After a 0.7-second time delay (due to delaying action of C114), beam recycle relay K107 energizes because of closure of contacts 2 and 4 of K108.

(4) When K107 is energized, contacts 6 and 8, and 3 and 4 of K107 close.

(5) Contacts 3 and 4 of K107 provide a holding circuit for beam-holding relay K106.

(6) Contacts 6 and 8 of K107 energize K108 and K302, causing high voltage to be applied to the klystron.

(7) Beam recycle relay K107 does not release immediately when K108 is reenergized (contacts 2 and 4 of K108 open), so that if the overload was transient in nature, contacts 6 and 7 of K303 will be closed before contacts 3 and 4 of K107 open. In this event, normal operation is resumed.

(8) If the overload was not transient, contacts of current overload relay K303 reopen immediately upon the reapplication of high voltage to the klystron. This action causes the release of beam-holding relay K106, which removes high voltage and stops the recycling sequence.

b. A klystron current overload activates the alarm circuit and extinguishes BEAM indicator DS105. This is due to a loss of RF, which energizes direct-alarm relay K103 and closes contacts 2 and 4. Alarm auxiliary relay K109 remains energized during an overload, since its holding circuit can only be broken by beam OFF switch S102.

73. Power-Off Sequence (fig. 160)

Depressing beam OFF switch S102 opens the holding circuit for K106 and K109. Subsequently, open contacts 1 and 2 of K106 open the holding circuit for relays K108 and K302, and high voltage is removed. Filament interlock relay K104 and time delay relay K105 are un-

affected and remain energized. Placing FILAMENT switch S101 in the OFF position removes power from the klystron blower, and removes line voltage from klystron filament transformer T302 and power supply transformer T101.

Section V. CONTROL PANEL MONITORING AND PROTECTIVE CIRCUITS

74. General

a. The control panel contains monitoring circuits that energize alarms if the output incident power becomes too low or if the reflected power becomes too high. The monitoring circuit also causes the beam voltage to be removed if the reflected power exceeds a predetermined value. Functional details are covered in paragraphs 75 through 82.

b. Metering circuits for monitoring filament voltage, beam voltage, beam current, power-in, and power-out are covered in paragraph 83.

75. Chopper Circuit (fig. 159)

a. Chopper Input Circuit. Directional coupler DC202 supplies two low-level dc inputs to the chopper circuit. One input is proportional to the incident output power. The other input is a sample of the reflected output power. The dc inputs to the chopper are converted to 400-cps signals by the switching action of the diode chopper circuit. The diode chopper uses a 6.3-volt ac control voltage from transformer T101, which alternately switches the diodes from a conducting state (low resistance) to a nonconducting state (high resistance). The two sets of diodes (CR101, CR102, and CR103; and CR104, CR105, and CR106) operate like switches alternately opening and closing. Diodes CR102 and CR105 reduce the reverse voltage on the chopper diodes. Potentiometers R109 and R110 are used to balance the circuit when only the 6.3-volt ac input is present.

b. Reflected Power Output Chopper Circuit. The dc sample of the reflected power output is coupled from DC202 through isolating resistor R103 to the junction of CR101 and CR103. As the voltage at terminal 10 of T101 becomes positive, diodes CR101 and CR103 conduct. This causes the junction of R103 and C101 to appear as a low impedance to ground, shorting the dc input to ground. When the voltage at terminal 8 of T101 becomes positive, diode CR102 conducts, while diodes CR101 and CR103 present a high impedance to the dc input at the junction of R103 and C101. The chopper circuit output voltage at the junction of R103 and C101 appears as a square wave which is coupled through C101, developed across grid resistor R113, and applied to relay amplifier V101A.

c. Incident Output Power Chopper Circuit. The dc sample of the incident power output from DC202 is coupled to the junction of CR104 and CR106. The operation of this chopper circuit is similar to that described in *b* above. The voltage at the junction of R104 and C102 appears as a square wave which is coupled through C102, developed across grid resistor R114, and applied to relay amplifier V101B.

76. Relay Amplifier V101A (fig. 159)

a. The square-wave output from the chopper circuit (para. 75) representing the reflected power is applied to the control grid of relay amplifier V101A through C101. The amplified output developed across plate load resistor R115 is applied to relay amplifier V103A, through capacitor C103.

b. Cathode bias for V101A is furnished by a voltage divider consisting of resistors R117 and R119 connected between ground and the plate circuit of V103A. This circuit also provides a feedback to the cathode circuit of V101A and improves the gain stabilization of the amplifier.

77. Relay Amplifier V103A (fig. 159)

a. The amplified output of V101A is applied to the grid (pin 2) of V103A, through capacitor C103 and potentiometer R121. The amplified output developed across plate load resistor

R128 is applied to a voltage-doubler rectifier circuit at the input of relay control V103B and also to cathode follower V102A.

b. Potentiometer R121 is adjusted so that reflected alarm relay K102 deenergizes when the reflected power exceeds 80 watts. Unbypassed cathode resistor R125 provides cathode degeneration, thereby providing gain stabilization for V103A.

78. Relay Control V103B
(fig. 159)

a. General. During normal operation (when the reflected power output does not exceed 80 watts), relay control V103B is conducting. The coil of reflected alarm relay K102 is the plate load for V103B. The plate current flow through the coil winding holds the relay in the energized position. When the reflected output power increases, the increase is amplified by V101A and V103A. The amplified output of V103A is applied to a voltage-doubler rectifier circuit consisting of CR108 and CR111. A dc voltage furnished by a voltage divider consisting of R131 and R134 is applied as bias voltage to CR108. When the output signal at the plate of V103A exceeds the bias voltage applied to CR108, the voltage-doubler circuit (*b* below) develops a negative dc voltage which is applied to the grid of V103B and cuts off the tube.

b. Voltage-Doubler Rectifier Circuit CR108 and CR111. The voltage-doubler rectifier circuit begins to function when the output signal of V103A, during the positive excursion of the plate signal, is sufficiently positive to overcome the bais voltage on CR108. When the V103A output signal exceeds the bias voltage on CR-108, capacitor C107 charges through CR108. During the negative excursion of the plate output signal, C107 discharges through CR111 and charges C110. On the next positive excursion, the action is repeated and C107 is charged through CR108. Note that the only discharge path for C110 is through the high resistance (1 megohm) of R137. As a result, before C110 can discharge, it is recharged through CR111 when C107 discharges. Subsequently the dc voltage across C110 builds up to approximately twice the peak-to-peak amplitude of the V103A plate output signal.

c. V103 Output Circuit. When C110 charges to the value determined by the setting of potentiometer R121 (para. 77), the negative voltage across C110 is applied to the grid of V103B. This action cuts off V103B and permits relay K102 to deenergize. When K102 deenergizes, contacts 3 and 4 close. This completes the circuit to alarm lamp DS106 and alarm buzzer DS 301. When the reflected output power decreases, the decreased negative voltage at the grid of V103B allows the tube to conduct, and relay K102 energizes, thereby disabling the alarm circuit.

79. Cathode Follower V102A
(fig. 159)

The output of relay amplifier V103A (para. 77) is applied to the control grid of V102A, through capacitor C105, and developed across reflected-off adjust potentiometer R122 and common grid-cathode resistor R127. Potentiometer R122 permits adjustment of the input signal level so that reflected-off relay K101 deenergizes when the reflected power increases to 100 watts. Bias voltage is developed across resistor R127. The output signal is developed across R124 and R127 and applied to a voltage-doubler rectifier circuit at the input of relay control V102B.

80. Relay Control V102B
(fig. 159)

a. During normal operation, relay control V102B is conducting. The coil of reflected-off relay K101 serves as the plate load for V102B. Tube plate current maintains K101 energized and contacts 2 and 4 complete a holding circuit for beam-holding relay K106. When the reflected power increases to 100 watts, plate current through V102B decreases and K101 is deenergized. Contacts 2 and 4 open and break the holding circuit for K106. Relay K106 deenergizes and removes the beam voltage from klystron V201.

b. The output of cathode follower V102A is applied to voltage-doubler rectifier CR107 and

CR110, through capacitor C106. The dc bias for CR107 is furnished by voltage divider R130 and R133. This voltage-doubler rectifier circuit is similar to the voltage-doubler rectifier described in paragraph 78*b*. When the negative voltage across C109 reaches a predetermined level (as determined by the setting of potentiometer R122), plate current through V102B decreases and relay K101 deenergizes.

81. Relay Amplifiers V101B and V104A (fig. 159)

The square-wave output from the chopper circuit (para. 75), representing the incident output power, is passed through two stages of amplification and applied to a relay control stage.

a. Relay Amplifier V101B. The output from the chopper circuit is applied to the control grid of V101B, through C102, and developed across grid resistor R114. The amplified output developed across plate load resistor R116 is coupled through C104 to relay amplifier V104A.

b. Relay Amplifier V104A. The input signal to V104A is developed across potentiometer R123. Potentiometer R123 permits adjustment of the signal input level so that relay K103 is energized when the incident output power decreases to 800 watts or lower. Cathode resistor R126 is unbypassed to provide cathode degeneration for gain stabilization of the amplifier. The amplified output developed across plate load resistor R129 is applied through a voltage-doubler rectifier circuit to the input of relay control V104B.

c. Feedback Network. A feedback from the plate circuit of V104A is coupled through resistor R120, developed across resistor R118, and applied to the cathode of V101B. The feedback signal stabilizes the gain of V101B and V104A.

82. Relay Control V104B (fig. 159)

a. During normal operation, direct-alarm relay K103 is deenergized. When the incident power output decreases to 800 watts or lower, the negative bias on V104B is reduced and the plate current flow through the tube increases. The plate load for V104B is the coil of relay K103. An increase in plate current causes relay K103 to energize. The closing of contacts 2 and 4 completes the circuit to energize ALARM lamp DS106 and klystron rf power buzzer DS-301.

b. The output of V104A is applied to voltage-doubler rectifiers CR109 and CR112 through C-108. The dc bias for CR109 is furnished by voltage divider R132 and R135. Operation of this voltage-doubler rectifier is similar to that of the voltage-doubler rectifier covered in paragraph 78*b*. During normal operation, the voltage across C111 provides cutoff bias for V104B so that relay K103 remains deenergized. When the incident output power decreases, the negative voltage across C111 is also reduced. This action decreases the bias on V104B and increases current flow through the tube. When C111 discharges below the preset value determined by R123, relay K103 energizes.

83. Power Amplifier Metering Circuits (fig. 159)

The metering circuits are contained in the power supply drawer and the control panel.

a. Filament Voltage. Filament voltage is measured by FILAMENT VOLTAGE meter M103 located on the control panel. To isolate meter M103 from the high voltage present at the klystron filament, an indication of the filament voltage is measured at the primary side of the filament transformer across a voltage-divider network consisting of resistors R302, R303, and R304. Resistor R303 is used to calibrate the meter.

b. Beam Voltage. Beam voltage is measured by BEAM VOLTAGE meter M104 located on the control panel. Meter M104 is connected across resistor R316, part of a voltage-divider network consisting of resistors R306 through R315, which is connected across the output of the klystron power supply.

c. Beam Current. Klystron collector current is measured by BEAM CURRENT meter M-105. Meter M105 is connected in series with the positive output of the power supply to the

collector and klystron overload relay. If the beam current increases to an unsafe value, relay K303 energizes and removes the beam voltage.

d. Power In. Incident and reflected input power is measured by POWER IN meter M-101 located on the control panel. Incident and reflected input power from directional coupler DC201 is applied to selector switch S104. Selector switch S104 determines whether incident or reflected power is measured.

e. Power Out. Incident and reflected output power from directional coupler DC202 is simultaneously measured on POWER OUT meter M102 located on the control panel. The output voltage standing wave ratio (vswr) is also indicated on the meter.

f. Total-Time Meters. The total time that filament and beam voltages are applied to the klystron is indicated in hours by FILAMENT meter M301 and BEAM meter M302 located on the power supply drawer.

84. Power Supply
(fig. 159)

Operating voltages for the monitor and protective circuits of the power amplifier are supplied by a power supply mounted on the control panel chassis.

a. When FILAMENT switch S101 is set to the ON position, single-phase 120-volt, 400-cps power is applied to the primary winding (terminals 1 and 2) of T101.

b. Transformer winding 8 and 10 provides 6.3 volts ac for the filaments of tubes V101 through V104 and the chopper circuit. The center tap of the secondary winding (terminal 9) is grounded and provides a balanced output to the chopper circuit.

c. The output of secondary winding 3–5 is applied to a full-wave rectifier circuit consisting of diodes CR115 through CR118. Resistors R155 through R158 equalize the inverse voltage across the diodes. The output is filtered by L101 and C112, and coupled through series resistor R140 to a voltage-regulator circuit consisting of voltage-regulator tube V105 and resistor R-139. The regulated 150-volt dc output is applied to the plate circuits of tubes V101, V102A, V103A, and V104A. The unregulated dc output from the junction of resistors R140 and R139 is applied, through relays K101, K102, and K103, to the plates of tubes V102B, V103B, and V-104B, respectively.

CHAPTER 6

FUNCTIONING OF AMPLIFIER-CONVERTER AM–3302/TRC–80

Section I. BLOCK DIAGRAM

85. General

a. Incoming signals, in the 4.4- to 5.0-kmc range, from the antenna are applied to the input of Amplifier-Converter AM–3302/TRC–80 (receive converter). A local input frequency, in the 30.075- to 34.225-mc range, from the synthesizer is multiplied by a factor of 144 to produce an injection signal in the 4330.8- to 4,928.4-mc range. The 4.4- to 5.0-kmc received signal is mixed with the injection signal to produce the 70-mc intermediate-frequency (IF) signal. The 70-mc signal is then applied to the IF amplifier (para. 97).

b. Two identical receive converters are used in the AN/TRC–80 to provide diversity reception. Refer to the radio set block diagram (fig. 38, TM 11–5820–469–20) and to paragraphs 54, 55, and 56 of TM 11–5820–469–20 for the block diagram discussion on the complete set.

86. Receive Converter Block Diagram (fig. 5)

a. Oscillator Unit. With switch S1 set to the EXT position (normal operating position), a stable frequency, in the 30- to 34-mc range, from the synthesizer is applied to buffer amplifier V2. Internal oscillator V1 may be used to supply an internal signal when switch S1 is placed in the INT position. However, this facility is not normally used when the AN/TRC–80 is utilized as part of the Pershing Weapons System. The input signal to V2 is amplified and applied to frequency tripler V3 to produce an output in the 90- to 102-mc frequency range. The frequency-tripler output is applied to buffer amplifier V4. The amplified output of V4 is applied to the multiplier unit for further frequency multiplication.

b. Multiplier Unit and Varactor Multiplier. The output from the oscillator unit is applied to the multiplier unit. A multiplying factor of 12 is achieved in the multiplier unit by the use of two frequency-doubler stages and a frequency-tripler stage. The 90- to 102-mc input to V1 is doubled and a 180- to 205-mc signal is applied to V2 for amplification. The output of V2 is applied to frequency doubler V3. The 360- to 410-mc output of V3 is applied to frequency tripler V4 to produce an output frequency in the 1,082- to 1,232-mc range. The output of the multiplier unit is applied to the varactor multiplier where the input frequency is multiplied by a factor of 4. The 4,330.8- to 4,928.4-mc output signal from the varactor multiplier is coupled to the mixer stage in the 70-mc tuneup oscillator.

c. Tuneup Signal. During the tuning procedure, when no input signal is being received, the TUNE-UP SIGNAL switch is depressed. This action activates 35-mc oscillator V1A. The 35-mc output of V1A is doubled by frequency-doubler stage V1B, and a 70-mc signal is applied to the mixer stage. The output of the varactor multiplier is heterodyned in the mixer stage with the 70-mc signal from the tuneup oscillator. The *sum* of the two signals (upper sideband) is applied to the tuneup signal injector stage and, from this point, the upper sideband signal is treated as a regular received signal (*d* below). This signal is used for checking the operation of the converter during test or tuning procedures to simulate an input signal.

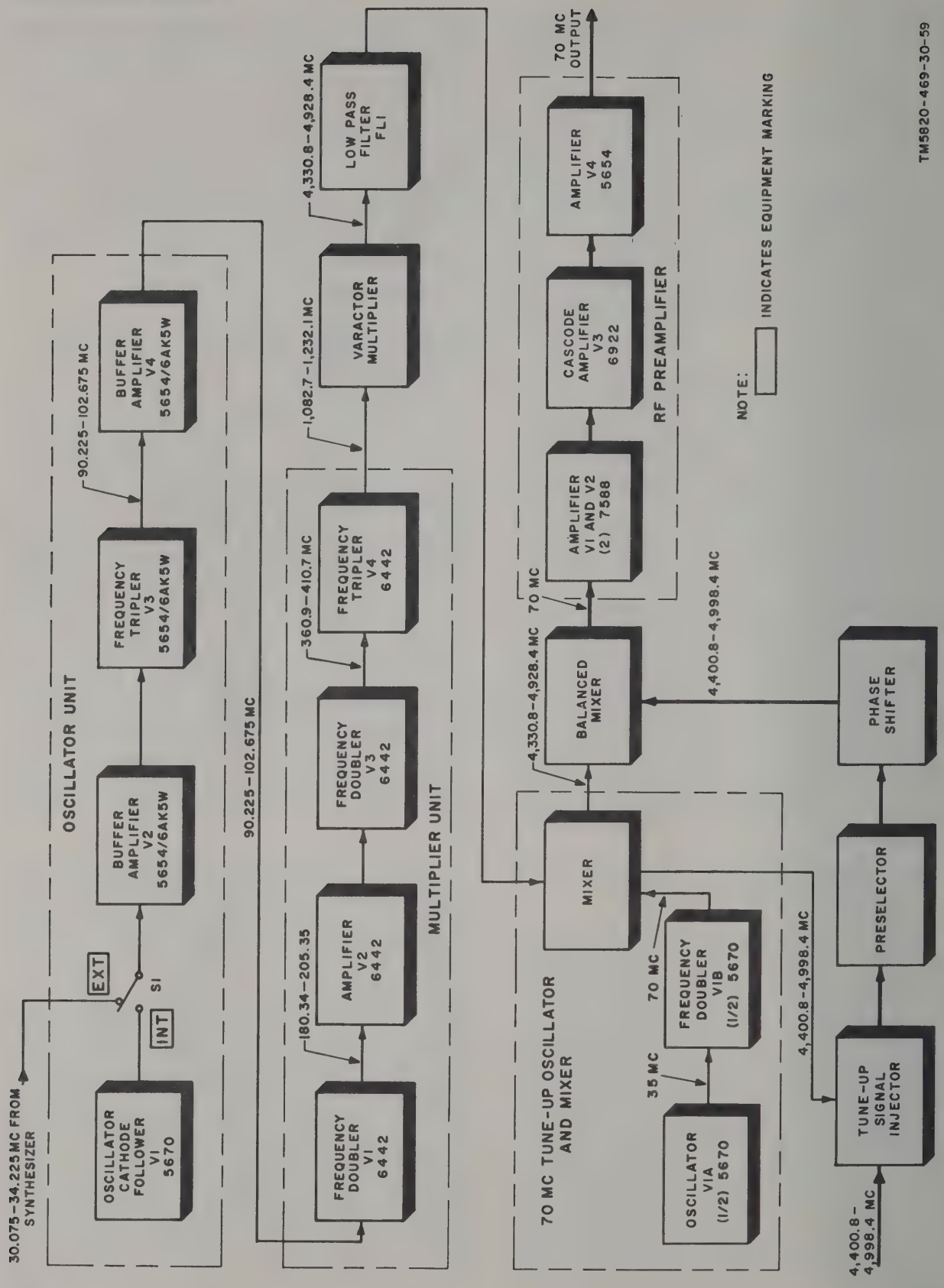


Figure 5. Receive converter, block diagram.

d. Input Signal Path. A received signal in the 4,400.8- to 4,998.4-mc frequency range is coupled through the tuneup signal injector, preselector, and phase shifter to the balanced mixer. The received signal is mixed with the varactor multiplier output, and the difference of these two signals, a 70-mc signal, is applied to the RF preamplifier stages. The 70-mc signal is coupled through four stages of amplification and applied to the IF amplifier (para. 97).

Section II. CIRCUIT FUNCTION

87. General

The receive converter accepts a received signal in the 4.4- to 5.0-kmc range and converts it to a 70-mc intermediate frequency. Three units, the oscillator, multiplier, and varactor multiplier, are identical with those used in the transmit converter. The circuit details for these components are covered in paragraphs 51, 52, and 53. The circuit details for the remaining units of the receive converter are covered in paragraphs 88 through 96.

88. Injection Signal Input
(fig. 161)

a. The output of the varactor multiplier, in the 4,330.8- to 4,928.4-mc range, is coupled from the output loop of varactor multiplier A3 through J2 and low-pass filter FL1 (which removed spurious harmonics), to 70-mc tuneup oscillator mixer A4. During normal operation, 70-mc oscillator mixer A4 has no effect on the varactor multiplier injection signal. The injection signal is passed on to variable attenuator AT1, coaxial transition A5, and balanced mixer A8, where the injection signal is mixed with the input rf signal (para. 89) to produce a 70-mc output signal which is applied to the RF preamplifier (para. 91).

b. During testing and tuneup procedures, when no input signal is being received, the injection signal from the varactor multiplier is mixed with the output of the 70-mc oscillator to produce a sum frequency (4.4 to 5.0 kmc) which is applied from mixer A4 direct to tuneup signal injector A10 through J2–P9 and P12–P1. This tuneup signal takes the place of a received input signal and follows the same path as the received signal (para. 89). The tuneup oscillator is covered in paragraph 96.

89. Received Input
(fig. 161)

a. Tuneup Signal Injector A10. The received 4.4- to 5.0-kmc signal from the antenna is applied to input connector J1 of A10. Tuneup signal injector A10 is a section of waveguide that couples the received signal to preselector A6 and also provides an injection point for the tuneup signal (para. 96).

b. Preselector A6. The preselector is made up of 3 tunable waveguide cavities with an average bandpass of 15 mc. This unit is tuned to the received signal. The output of the preselector is applied to phase shifter A7 which shifts the phase of the received signal slightly to obtain optimum impedance matching for balanced mixer A8. The output of phase shifter A7 is coupled to balanced mixer A8.

c. Balanced Mixer A8. The received signal (*a* above), in the 4.4- to 5.0-kmc range, and the varactor multiplier injection signal (para. 88*a*), in the 4,330.8- to 4,928.4-mc range, are heterodyned by the action of crystals CR1 and CR2 and a tuned 70-mc output circuit in the balanced mixer. The difference frequency (70 mc) at the junction of CR1 and CR2 is applied to RF preamplifier unit A9. The signal detected by CR2 is developed across resistor R11 and XTAL CURRENT ADJUST R10, and applied through S1 to meter M1 for monitoring purposes.

90. Receive Converter Main Chassis
(fig. 161)

a. General. The main chassis of the receive converter provides interconnecting facilities for the oscillator unit, multiplier unit, varactor multiplier, tuneup oscillator, RF preamplifier, and other minor components. A filament supply

and metering circuit is also located on the main chassis.

b. Power Supply Circuits. An input of 120 volts ac is applied to the primary of filament transformer T1. The output at the secondary of T1 is applied to the oscillator unit, multiplier unit, 70-mc tuneup oscillator, and the RF preamplifier. The B+ voltage for these units, applied through pins B and C of J4, is obtained from the converter power supply (para. 137).

c. Minor Components. The inputs and outputs to jack J4 are filtered by chokes L1 through L6, L8, and L9, resistor R14, and capacitors C1 through C9. The inputs and outputs of the oscillator unit are filtered by chokes L10 through L15 and capacitors C10 through C15, and C24. Resistors R2 through R6, and R8 and R9 are current-limiting resistors for the meter circuits. Chokes L16 through L22, and capacitors C16 through C22 filter the inputs and outputs of the multiplier unit. Potentiometers R12 and R13 are adjusted to maintain on-scale meter readings. Selector switch S1 selects the various functions to be monitored.

91. RF Preamplifier Unit A9
(fig. 162)

The RF preamplifier unit is a four-tube RF amplifier tuned to a center frequency of 70 mc. This unit amplifies the 70-mc output signal from the balanced mixer and applies the amplified signal to the 70-mc IF amplifier (para. 97). Circuit details for RF preamplifier unit A9 are covered in paragraphs 92 through 95.

92. RF Amplifier V1
(fig. 162)

a. Input Circuit. The 70-mc signal from the balanced mixer is applied to plug P1. The input signal is coupled by capacitor C1 to a resonant circuit, consisting of inductor L1 and L2, and capacitors C2 and C3, tuned to 70 mc. Voltage divider R15 and R16 provides a fixed bias for the grid of V1. Capacitor C30 provides an RF ground return for the grid circuit. Cathode bias is furnished by R1, which is bypassed by C5.

b. Output Circuit. The amplified output developed across inductor L13 is coupled, through capacitor C6 and parasitic suppressor R2, to amplifier V2. A neutralizing network consisting of C4 and L4 prevents oscillation of V1 and reduces the overall noise figure within the stage. Resistor R17 and capacitor C32 form a plate-decoupling network.

93. RF Amplifier V2
(fig. 162)

a. Input Circuit. The output signal from V1 is applied to the cathode of V2. The input signal is developed across inductor L14. Resistor R3 and bypass capacitor C7 make up the bias network. Amplifier V2 operates as a grounded-grid amplifier. The grid of V2 is grounded at the input signal frequency by capacitor C24. Voltage divider R18 and R19 provides a fixed bias for the grid of V2. Resistor R4 and capacitor C33 provide decoupling for the grid circuit.

b. Output Circuit. The amplified output is developed across a double-tuned circuit consisting of inductors L5, L6, and L7, and capacitors C8, C9, and C12. The circuits are tuned to 70 mc. Loading resistor R5 broadens the bandwith of the circuit. The amplified output is applied to cascode amplifier V3. Resistor R20 and C34 form a plate-decoupling network.

c. Metering Network. The signal voltage at the plate of V2 is also coupled by capacitor C10 to diode CR1. The signal is rectified by CR1, filtered by resistor R6 and capacitor C11, and applied to test jack J2 for monitoring and tuning purposes.

94. Cathode Amplifier V3
(fig. 162)

a. Tube V3A. Tube V3A functions as the cathode circuit for V3B. The output of amplifier V2 (para. 93) is applied, through C13, to the grid (pin 2) of V3A. The amplified output signal at the plate (pin 1) is applied, through parasitic suppressor R9, to the cathode (pin 8) of V3B. Since the plate of V3A is directly

coupled to the cathode of V3B, the same current flows through both tube sections. Voltage divider R21 and R22 provides a fixed bias for the grid of V3A. Resistors R7 and R21 complete the grid path to ground. Cathode bias is furnished by R8 and bypass C14.

b. Tube V3B. Tube V3B functions as a grounded-grid amplifier. The grid is grounded at the input signal frequency by C36. The input signal at the cathode is amplified and developed across a double-tuned circuit consisting of inductors L8, L9, and L10, and capacitors C15, C16, and C19. Resistors R10 shunts the tuned circuit to increase the bandwidth. The output tuned circuit is coupled by C20 to amplifier V4. Resistor R25 and capacitor C37 are the plate-decoupling network.

c. Metering Network. The output signal at the plate of V3B is also coupled by C17 to diode CR2. This signal is rectified by CR2 and filtered by R11 and C18, and applied to test jack J3 for monitoring and tuning purposes.

95. RF Amplifier V4
(fig. 162)

a. Input Circuit. The output of cascode amplifier V3 is coupled through C20, developed across grid resistor R12, and applied to the grid (pin 1) of V4. Voltage divider R26 and R27 provides fixed bias for the grid. Capacitor C38 prevents RF feedback to B+. The cathode-bias network consists of resistor R13 and bypass capacitor C21. Resistor R30 is a screen-grid voltage-dropping resistor, and capacitor C22 is a screen-grid bypass. Screen-grid decoupling is provided by R28 and C39.

b. Output Circuit. The amplified output developed across plate load resistor R31 is coupled, through an impedance-matching network consisting of L11 and C23 and C27, to jack J1. Resistor R29 and capacitor C40 form a plate-decoupling network. The output signal from the RF preamplifier unit is coupled from J1, through P11, to module A1 in the IF amplifier (para. 103).

c. Metering Network. The output signal is also coupled by C25 to CR3. The signal is rectified by CR3, filtered by R14 and C26, and applied to J4 for monitoring and tuning purposes.

96. Tuneup Oscillator and Mixer
(fig. 6)

a. General. The 70-mc oscillator unit is used for testing and tuning the receive converter to the correct receiving frequency. The oscillator circuit consists of a twin-triode tube and a quartz crystal connected in a Butler oscillator circuit. The two cathodes of V1 are coupled together by crystal Y1 which is series resonant at 35 mc. Section A of V1 operates as a grounded-grid amplifier. The grid of V1A is grounded at the crystal frequency by C1 and C2. Section B operates as a frequency doubler.

b. Oscillator V1A. The resonant circuit at the plate of V1A, consisting of L1 and C3, is tuned to 35 mc by C3. The output signal, developed across the resonant circuit, is applied to doubler V1B through C6.

c. Frequency Doubler V1B. When the resonant circuit at the plate of V1A is properly tuned, V1B draws grid current. The flow of grid current produces harmonics at the plate of V1B. A resonant circuit consisting of L2 and C9 selects the second harmonic (70 mc) of the input frequency. The 35-mc signal appears at the cathode of V1B, where it is fed through crystal Y1 to complete the oscillation loop. The output signal is applied, through C12, to CR1 in the mixer. The output signal is also applied, through isolating resistor R9, to test point TP2 and to pin A of J1. The metering circuit output (pin A) is filtered by rf chokes L9 and L10 and capacitors C17 and C20.

d. Injection Signal. The injection signal in the 4,330.8- to 4,928.4-mc range is coupled through the mixer circuit. The injection signal is heterodyned with the 70-mc output signal from the tuneup oscillator to produce upper sideband signals in the 4.4- to 5.0-kmc range. The tuneup signal output is applied to P1 in the tuneup signal injector (fig. 161).

e. Minor Components. The following chart lists the functions of the minor components:

Component	Function
R4 and R5	Plate-decoupling resistors
C5 and C7	Plate-decoupling capacitors
L4, L5, L7, C13, C14, C15, and C18.	Filament filter network
L3, L8, C8, C16, and C19	Plate supply filter network
R1 and R7	Grid dc return
R3 and R6	Cathode-bias resistors
R2	Lowers Q of V1A plate-tuned circuit.
L6 and R10	Input impedance for 70-m signal applied to crysta mixer CR1.

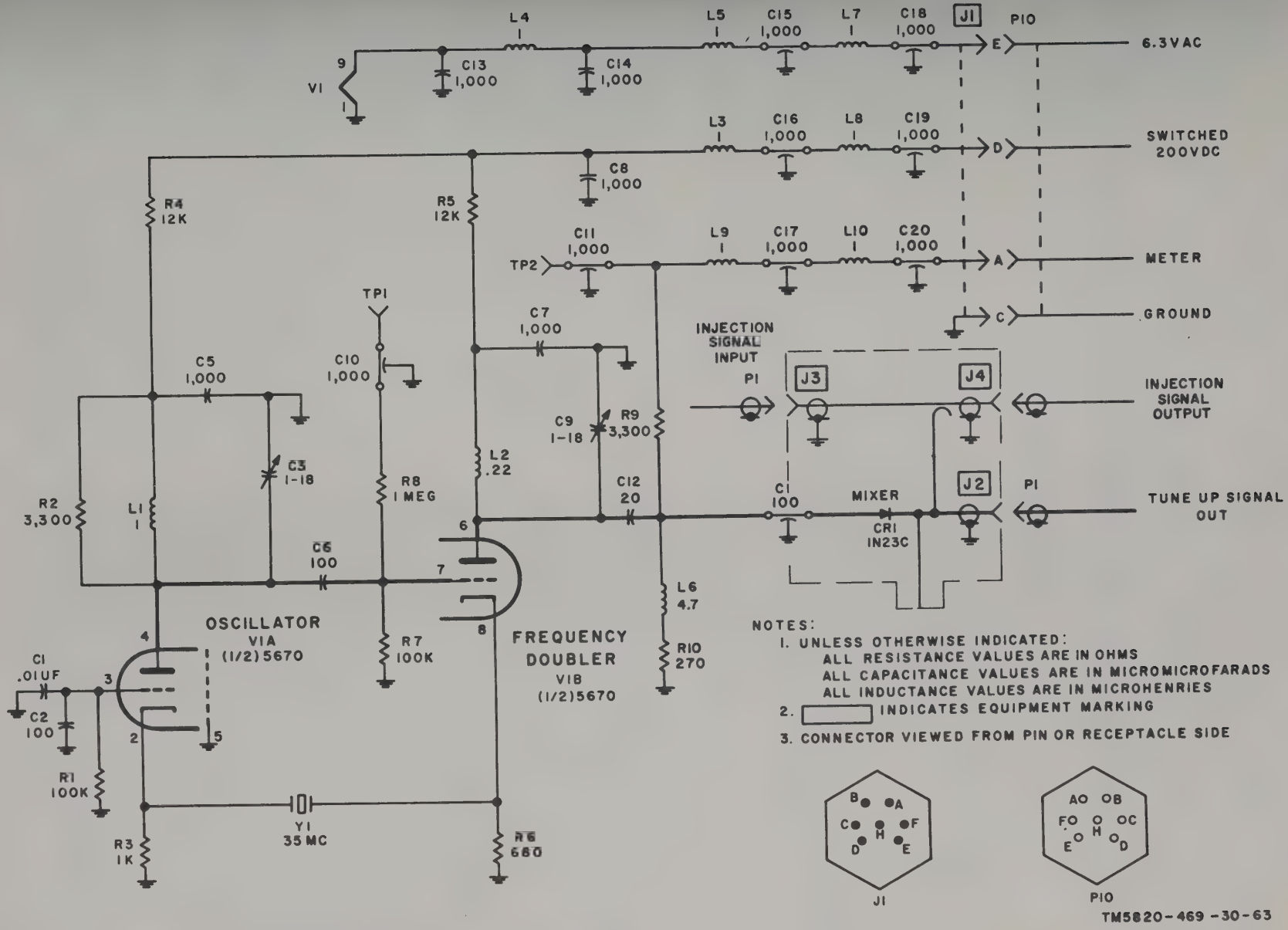


Figure 6. Tuneup oscillator and mixer, schematic diagram.

CHAPTER 7

FUNCTIONING OF AMPLIFIER, INTERMEDIATE FREQUENCY AM–3288/TRC–80

Section I. BLOCK DIAGRAM

97. General

a. Amplifier, Intermediate Frequency AM–3288/TRC–80 (IF amplifier) receives a 70-mc IF signal from the receive converter and provides a multiplex output signal to the multiplexer unit. Two IF amplifiers are available in this equipment, and their outputs are normally connected in parallel to provide diversity reception. Refer to TM 11–5820–469–10 for connection details, and to figure 38 of TM 11–5820–469–20 for the radio set block diagram.

b. The function of the IF amplifier with respect to the other units of the AN/TRC–80 is covered in TM 11–5820–469–20.

c. The IF amplifier consists of 70–8-mc converter module A1, bandwidth control module A2, 8-mc IF amplifier No. 1 module A3, 8-mc IF amplifier No. 2 module A4, and discriminator-combiner module A5.

98. Converter A1, 70–8 Mc
(fig. 163).

a. Amplifiers V1 and V2. A 70-mc IF signal from the receive converter (para. 95*b*) is applied to 70- to 8-mc converter module A1. The 70-mc input signal is amplified by stage V1 and applied to amplifier V2. The amplified IF output of V2 is applied to mixer V3.

b. Crystal Oscillator and Doubler V5. Tube V5 functions as a crystal-controlled oscillator and as a frequency doubler. A crystal, operating at 39 mc, is used as the basic frequency source. This frequency is doubled to produce a 78-mc output which is used as an injection signal for mixer V3.

c. Mixer V3. The 70-mc IF signal and the 78-mc injection signal are mixed in mixer stage V3. The 8-mc difference signal is selected and applied to amplifier V4.

d. Amplifier V4. Two stages of amplification are obtained in V4. The 8-mc IF signal is applied to V4A, where it is amplified and applied to amplifier V4B. The amplified output of V4B is applied to bandwidth control A2.

99. Bandwidth Control A2
(fig. 163)

a. Amplifier V1 and Bandwidth Control Circuit. The 8-mc IF signal from the 70–8-mc converter is applied to amplifier V1. The amplified output from V1 is coupled to a tuned circuit and cathode follower V2A. The tuned circuit determines the overall bandwidth of the receiver. Bandwidth control switch S2 selects the desired bandwidth for the operation of the radio set. With switch S2 in the 2 KMC position, a bandwidth of 75 kc is obtained. With switch S2 in the 4 KMC position (normal switch position when this equipment is used as part of the Pershing Weapons System), a bandwidth of 125 kc is obtained.

b. Cathode Follower V2A and Grounded-Grid Amplifier V2A and Grounded-Grid Amplifier V2B. The output from V1 is applied to cathode follower V2A. The cathode follower isolates the tuned circuit in the plate circuit of V1 from grounded-grid amplifier V2B. The output of V2A is coupled to V2B. The plate circuit of V2B drives amplifier V3.

c. Amplifier V3. The 8-mc IF signal from V2B is amplified again by V3. The 8-mc IF output of V3 is applied to 8-mc IF No. 1 module A3.

d. Shaper and Combiner-Control Circuit V4. A control voltage for diversity combiner V5 in the discriminator-combiner stage is shaped by V4. The combiner-control voltage, which is proportional to the signal strength, is derived from the two 8-mc IF sections and applied to V4B. A shaper control voltage from the first two stages of 8-mc IF module No. 2 is applied to amplifier V4A, which, in turn, controls the output of V4B. The output of V4B is applied to the grid of diversity combiner V5 and also to 8-mc IF module No. 2. These circuits determine the operating level of diversity combiner V5.

100. Eight-Mc IF Amplifiers A3 and A4 (fig. 163)

Eight-mc IF amplifier No. 1 and eight-mc IF amplifier No. 2 each use four dual-triodes operating as limited amplifiers. Under normal signal conditions, section A of each triode operates as a cathode follower, and section B of each triode functions as a grounded-grid amplifier. Under strong signal conditions, both sections of the triode operate as limiters (cathode-coupled clippers). The 8-mc IF output of 8-mc IF No. 2 is applied to discriminator-combiner A5. Control voltages developed in 8-mc IF amplifiers No. 1 and No. 2, are applied to shaper control V4A and combiner-control voltage shaper V4B in bandwidth control A2.

101. Discriminator-Combiner A5 (fig. 163)

The discriminator-combiner amplifies and recovers the intelligence from the 8-mc IF fm signal. In diversity operation, this unit combines the recovered signals from two receivers to produce a single output signal.

a. Amplifier V1 and V2. The 8-mc IF signal from 8-mc IF No. 2 is applied to limited amplifier V1, which amplifies and limits the input signal. The output of V1 is applied to amplifier V2. The amplified output of V2 is coupled to the discriminator circuit.

b. Discriminator V3. Discriminator V3 recovers the multiplex signal component from the 8-mc fm signal and applies the detected signal to phase splitter V4A.

c. Phase Splitter V4A. This stage accepts the multiplex input signal and provides equal-amplitude, out-of-phase outputs to V5A and V5B.

d. Diversity Combiner V5. The output signals from V4A drive V5A and V5B in push-pull. Also applied to V5A and V5B is a positive dc combiner-control voltage from the combiner-control shaping circuit located in the bandwidth control module. The control voltage (proportional to signal strength) establishes the operating level of combiner V5. The output from the cathode of V5A is coupled to the grid of V6A. The output from the cathode of V5B is coupled to the grid of V6B. Facilities are provided for connecting the combiner cathodes of one receiver in parallel with the cathodes of another combiner stage when two receivers are operated in diversity.

e. Differential Amplifier V6. The output signals from V5A and V5B drive V6A and V6B in push-pull. Undesired signal components of the combiner-control voltage are canceled by V6. The multiplex signal output is developed across a common load and applied to cathode follower V4B.

f. Cathode follower V4B. Cathode follower V4B matches the impedance of V6 to the output transformer impedance. When two receivers are operated in diversity, the outputs are combined and coupled, through the output transformer, to the multiplexer.

g. Test Oscillator Q4. The discriminator-combiner contains an 8-mc transistor oscillator, Q4, for test purposes. The oscillator, normally inoperative, is activated when BFO switch S1 is closed. The output of the oscillator is applied to V1 and mixed with the incoming signal to produce an output at the discriminator. The output is amplified and applied to a phone jack at the output of the module for monitoring the beat note. This provides a convenient means of assuring that the transmitter and receiver are on the correct frequency within acceptable limits.

Section II. 70–8 MC CONVERTER MODULE A1

102. General

The 70-mc IF signal from the receive converter (para. 95*b*) is amplified and applied to a mixer. A 78-mc injection signal produced by a crystal-controlled oscillator is also applied to the mixer. The two signals are mixed and the 8-mc difference signal is selected. This signal is amplified and applied to bandwidth control module A2.

103. Amplifier V1
(fig. 164)

a. Input Circuit. The 70-mc IF signal is applied to input jack J2. The input signal is developed across terminating resistor R1 and coupled to the grid (pin 1) by coupling capacitor C1. Resistors R2 and R3 form a voltage-divider network which establishes fixed bias for the grid circuit. Cathode bias is provided by R4 and C2. A 74-mc trap in the cathode circuit consisting of L11 and C55 is tuned by L11. Resistor R5 is a screen-grid voltage-dropping resistor, and capacitor C3 is the screen-grid bypass capacitor.

b. Output Circuit. The amplified output of V1 is applied to V2 through a 70-mc triple-tuned circuit and coupling capacitor C12. The first section of the tuned circuit, consisting of C7 and the primary of T1, is tuned by C7. The second section of the tuned circuit, consisting of C8, C10, the secondary of T1, and the primary of T2, is tuned by C10. The third section of the tuned circuit, consisting of C11 and the secondary of T2, is tuned by C11. Resistors R8 and R10 are used to broaden the bandpass characteristics of the tuned circuits. Resistor R7 and capacitor C9 form a plate-decoupling network.

c. Test Circuit. The amplified output signal is also applied to test jack J4 through coupling capacitor C6. The test signal is rectified by CR1 and filtered by R9 and C13.

104. Amplifier V2
(fig. 164)

Amplifier V2 is similar to amplifier V1 (para. 103) except that the cathode circuit does not contain a trap. The input to V2 is applied through C12. The output is developed across the triple-tuned 8-mc circuit and applied, through coupling capacitor C24, to mixer V3. The V2 output is also rectified and applied to J5 for test purposes.

105. Oscillator and Doubler V5
(fig. 164)

a. General. The 78-mc injection signal is generated by crystal-controlled oscillator V5. Section A of V5 operates as a grounded-grid amplifier, and section B operates as a cathode follower at the crystal frequency and also as a frequency doubler. Crystal Y1 functions as a series-tuned circuit at a frequency of 39 mc and is connected between the cathodes of the dual-triode tube.

b. Oscillator V5A. The signal from the crystal is developed across cathode resistor R43. The control grid is grounded at the crystal frequency by capacitors C42 and C61. The grid is returned to ground through resistor R42. The plate circuit of V5A contains a tuned circuit consisting of L2, C40, and C60. The circuit is tuned to 39 mc by capacitor C40. The bandpass characteristics of the tuned circuit are broadened by resistor R41. Resistor R39 and capacitor C41 form a plate-decoupling network. The 39-mc output signal at the plate is coupled to tube V5B through coupling capacitor C43.

c. Cathode Follower and Doubler V5B.

(1) The 39-mc output from V5A is developed across grid resistor R46 and applied to the control grid of V5B. The 39-mc component of the signal is developed in the cathode circuit across resistor R52 and applied to crystal Y1 as an in-phase feedback to complete the oscillator loop. The signal developed across cathode resistor R52 is also applied to test jack J8, through isolation resistor R45. Capacitor C46 provides a low-impedance path to ground for noise introduced through jack J8.

(2) The input signal to the control grid of V5B causes the grid to draw current. This action develops harmonics in the plate circuit. A tuned circuit, consisting of L3, C45, and C47, is tuned to select the second harmonic (78 mc) by capacitor C47. The 78-mc output signal is applied to test point E11 through C48, and from there is applied to mixer V3. The 78-mc signal is also applied through C49 to CR4. The signal is rectified by CR4, filtered by resistor R47 and capacitor C56, and applied as a dc test voltage at J7.

106. Mixer V3
(fig. 164)

a. The 70-mc IF signal and the 78-mc injection signal are mixed by V3 to obtain an 8-mc difference signal. The 70-mc IF signal from amplifier V2 is applied to the control grid of V3 through C24. This grid is returned to ground through R21. The 78-mc injection signal from oscillator V5 is applied to the suppressor grid of V3. The suppressor grid is returned to ground through R22 and R23. The two input signals and the sum and difference of the two input frequencies appear at the plate of V3. Network Z1 in the plate circuit is a fixed triple-tuned circuit which selects the 8-mc difference signal. The 8-mc IF output of Z1 is applied to V4 through C31. Capacitor C59 provides the required capacitance for the third section of Z1.

b. The signal developed across cathode resistor R23 is coupled to test jack J6 through C28. The test signal is rectified by CR3 and filtered by R26 and C29. Plate decoupling for the stage is provided by R25 and C30. Resistor R24 is the screen-grid voltage-dropping resistor and C27 is the screen-grid bypass capacitor.

107. Amplifier V4
(fig. 164)

Amplifier V4 uses a dual triode to provide two stages of amplification for the 8-mc IF signal.

a. Amplifier V4A. The 8-mc IF signal from mixer V3 is applied to the control grid of V4A through C31 and parasitic suppressor R50. Resistors R27 and R28, connected between the positive 200-volt dc supply and ground, form a voltage-divider network which establishes bias for the grid circuit of V4A. Cathode bias is furnished by R29 and C35. The amplified outputs developed in the plate circuit across plate load resistor R30 are coupled to V4B through coupling C34. Plate decoupling is provided by R31 and C33.

b. Amplifier V4B. Amplifier V4B is similar to V4A (*a* above). The signal voltage from V4A is applied to the control grid of V4B, through coupling capacitor C34 and parasitic suppressor R51. The amplified signal developed in the plate circuit, consisting of L1 and R36, is applied to output jack J3 through coupling capacitor C38. The output signal is also applied to test jack J9, through coupling capacitor C57. The test signal is rectified by CR5 and filtered by R49 and C58.

108. Filament and Plate Circuits
(fig. 164)

The plate and filament supply voltages are coupled through a filter unit located on converter A1. Choke coil L1 and capacitors C1 and C3 filter the plate supply voltage. Choke coil L2 and C2 and C4 filter the filament supply voltage. Additional filtering for the filament circuits is provided by choke coils L6 through L10 and L12, and capacitors C50 through C54. Interstage decoupling of the plate circuit is accomplished by resistors R6, R14, R19, R32, R33, and R48, and capacitors C4, C5, C19, C26, C32, and C36.

Section III. BANDWIDTH CONTROL MODULE A2

109. General

The bandwidth control module limits and determines the overall bandwidth of the receiver. The bandwidth may be set for 75 kc or 125 kc. When this equipment is used as part of the Pershing Weapons System, a 125-kc bandwidth is used. The shaping circuits, V4A and V4B, shape a diversity-combining control voltage

rom input voltages developed in the two 8-mc F amplifier subassemblies, A3 and A4.

10. Amplifier V1
(fig. 165)

a. The 8-mc IF signal from 70-8 mc converter A1 is applied to input jack J1 and coupled to the control grid of V1, through coupling capacitor C1. The control grid is returned to ground through resistor R1. The cathode circuit consists of RCVR GAIN control R4 and resistor R2. Capacitor C2 is the cathode bypass capacitor. Potentiometer R4 and resistor R37, connected between the positive 200-volt dc supply and ground, form a voltage divider and establish the bias for the cathode circuit. Capacitor C5 is a bypass capacitor for the voltage divider. Resistors R3 and R5, connected between the positive 200-volt supply and ground, form a voltage divider for the screen grid. Capacitor C3 is the screen-grid bypass. The amplified output at the plate of V1 is applied to cathode follower V2A through a single-tuned circuit and coupling capacitor C6.

b. The tuned circuit, consisting of capacitors C1, C2, C4, C47, and C48 and inductor L1, is tuned to 8 mc by capacitor C4. The overall bandwidth of the receiver is determined by this tuned circuit. Capacitors C1 and C2 and inductor L1 are inclosed in temperature-controlled oven HR1. With switch S2 in the 2KMC position, resistor R43 is connected across the tuned circuit. This action provides the proper loading to obtain a bandwidth of 75 kc. With switch S2 in the 4KMC position, resistor R42 provides the proper loading effect to obtain a bandwidth of 125 kc. Capacitor C50 prevents the dc voltage at the plate of V1 from being grounded through resistor R42 or R43.

Note. When this equipment is used as part of the Pershing Weapons System, switch S2 is always set to 4KMC.

11. Cathode Follower V2A
(fig. 165)

Cathode follower V2A isolates the tuned circuit of V1 and drives grounded-grid amplifier V2B. The signal voltage from amplifier V1 is coupled through C6, developed across grid resistor R6, and applied to the control grid of V2A. The output signal voltage is developed across cathode resistors R8 and R9 and coupled to the cathode of ground-grid amplifier V2B, through coupling capacitor C8. Cathode bias is developed across R8 and plate decoupling is provided by R7 and C7.

112. Amplifier V2B
(fig. 165)

a. The input signal voltage from V2A is coupled through C8 and R11 and developed across cathode resistor R13. The amplified output signal voltage at the plate of grounded-grid amplifier V2B is developed across a tuned circuit consisting of C47 and L9, and coupled to a second tuned circuit by capacitor C11. The tuned circuit consists of capacitors C14, C49, and inductor L1. The circuit is tuned to 8 mc by capacitor C14. The output of the tuned circuit is coupled to the tuned grid of amplifier V3 through series-connected capacitors C16 and C52.

b. The signal voltage from the tuned circuit is also applied to test jack J9, through coupling capacitor C53. The signal is rectified by CR5 and filtered by resistor R40 and capacitor C54.

c. Resistors R14 and R38, connected between the 200-volt supply and ground, form a voltage divider to establish bias for the grounded-grid amplifier. Capacitor C45 grounds the grid at the signal frequency. Resistor R10 and capacitor C10 form a plate-decoupling network.

113. Amplifier V3
(fig. 165)

a. Input Circuit. The amplified signal voltage from V2B is applied to the tuned grid circuit of amplifier V3, through coupling capacitors C16 and C52. The tuned circuit, consisting of C13, C15, and L2, is tuned to 8 mc by C13. The output from the tuned circuit is applied to the control grid of V3 through parasitic suppressor R17.

b. Output Circuit. The amplified signal voltage at the plate is developed across a double-tuned circuit and applied to output jack J2.

These double-tuned circuits provide a rejection of 60 decibels (db) or more to all signals removed by more than ±1 mc from the desired frequency. The first tuned circuit, consisting of C22, C23, C24, and L7, is tuned to 8 mc by C22. The output of this tuned circuit is coupled to the second tuned circuit by series-connected capacitors C27 and C42. The second tuned circuit, consisting of C25, C41, C51, and L8, is tuned to 8 mc by C25. Resistors R20 and R41 are used to broaden the bandpass characteristics of the two tuned circuits.

c. Minor Components. A voltage-divider network consisting of resistors R35 and R39 is connected between the 200-volt dc supply and ground. The voltage at the junction of these two resistors is applied as bias voltage to the control grid circuit of V3. Capacitor C46 is a bypass capacitor for the grid voltage-divider network. Cathode bias is furnished by R19, which is bypassed by capacitor C20. Resistor R34 is a screen-grid voltage-dropping resistor, and capacitor C39 is a screen-grid bypass capacitor. Plate decoupling is provided by R18 and C19.

114. Combiner-Control Voltage Shaper V4 (fig. 165)

a. General. Shaper control V4A and combiner-control voltage shaper V4B establish the operating level of diversity combiner V5 (para. 127). Shaper control circuit V4A is controlled by a shaper control voltage (positive dc voltage) derived from a voltage-doubler rectifier circuit located in 8-mc IF amplifier No. 2. Another dc control voltage, also proportional to the signal strength, derived from a series of detectors located in the 8-mc IF No. 1 and No. 2 (paras. 116 and 117), is applied to V4B. The output voltage from V4B is applied as a control voltage to diversity combiner V5 in discriminator-combiner module A5 (paras. 122–131).

b. Shaper Control V4A Input Circuit. A shaper control voltage derived from two series-connected voltage-doubler rectifiers in the cathode circuit of the first two stages of 8-mc IF amplifier No. 2 (paras. 116 and 117) is applied to pin 4 of J5. This voltage is filtered by C3, C8, and L4 in filter network FL1. The output of FL1 is applied to the control grid of V4A, through R22 and R24. Test jack J4 provides a test point for monitoring the input signal. Capacitor C28 and resistor R22 provide additional filtering of the input signal.

c. Combiner Control V4B Input Circuit. The input to combiner control V4B is derived from a series of rectifiers in the cathode circuit of the amplifiers located in 8-mc IF amplifier No. 1 and No. 2. This voltage is applied to pin 6 of jack J5 and filtered by C1, C6, and L1. The output of the filter network is applied, through R23, to the control grid of V4B and the collector of transistor Q1. Capacitor C29 provides additional filtering of the input signal.

d. Circuit Function. Both sections of V4 are used to produce the desired control voltage for diversity combiner V5. Refer to figures 7 and 8 for the combiner-control voltage distribution in racks A4 and A5. Refer to figure 190 for the complete functional schematic diagram of the combiner-control voltage application. The circuit operates as follows:

(1) Assume that a strong signal is present in the 8-mc IF amplifier No. 2.

(2) The strong signal produces a positive dc voltage (proportional to the input signal) which is applied to the control grid of V4A.

(3) The positive dc voltage at the grid of V4A causes V4A to conduct heavily and lowers the voltage at the plate of V4A below the breakdown voltage of Zener diode CR3.

(4) When CR3 stops conducting, transistor Q1 is cut off and functions as a high resistance in the grid circuit of V4B.

(5) The combiner-control input voltage to V4B is developed across the high resistance of nonconducting transistor Q1 and applied to the control grid of V4B. The output of V4B is applied as a control voltage to diversity combiner V5 (para. 127).

(6) When the incoming signal level drops, the positive voltage at the grid of V4A decreases and the plate voltage rises.

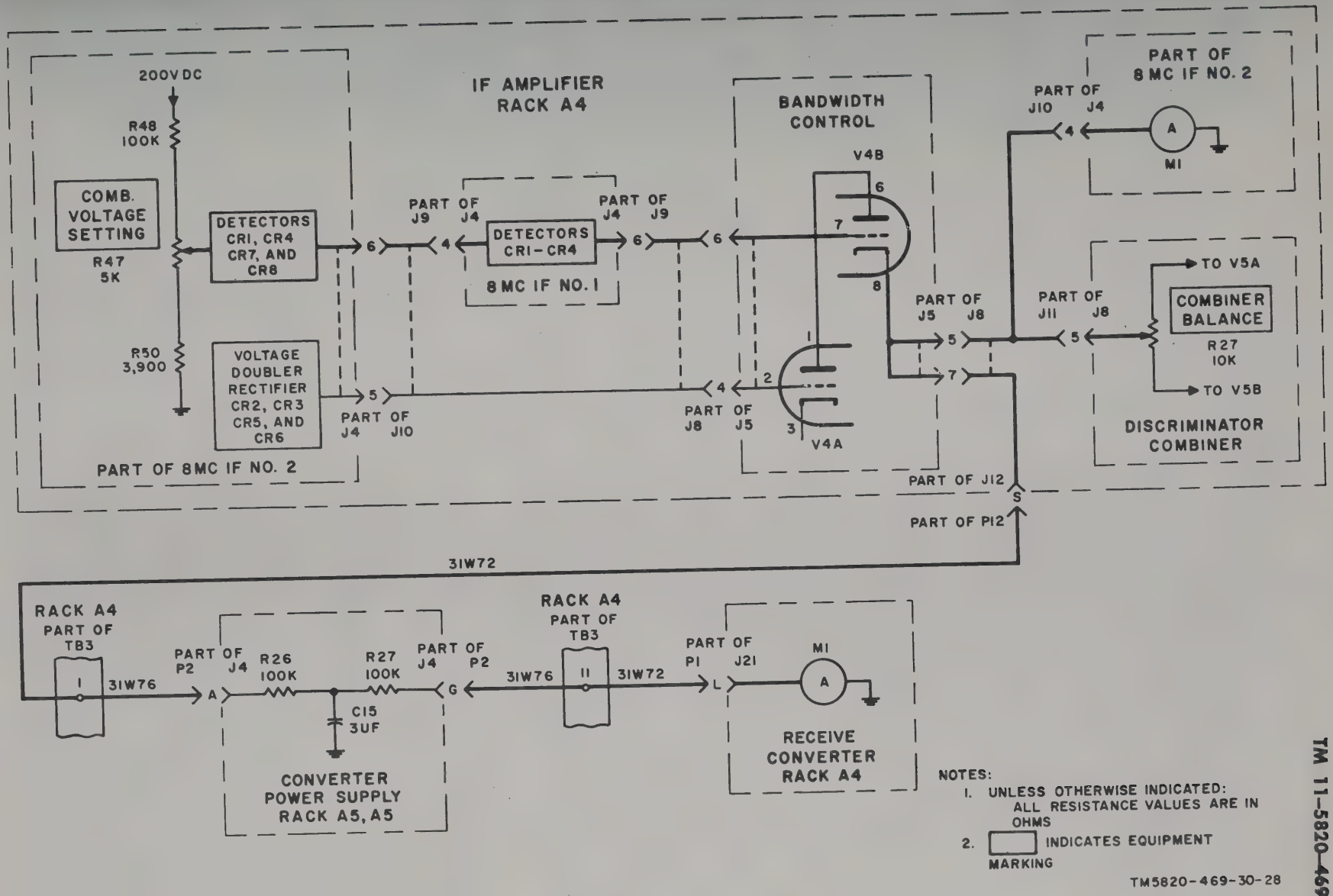


Figure 7. Combiner-control voltage distribution rack A4, simplified schematic diagram.

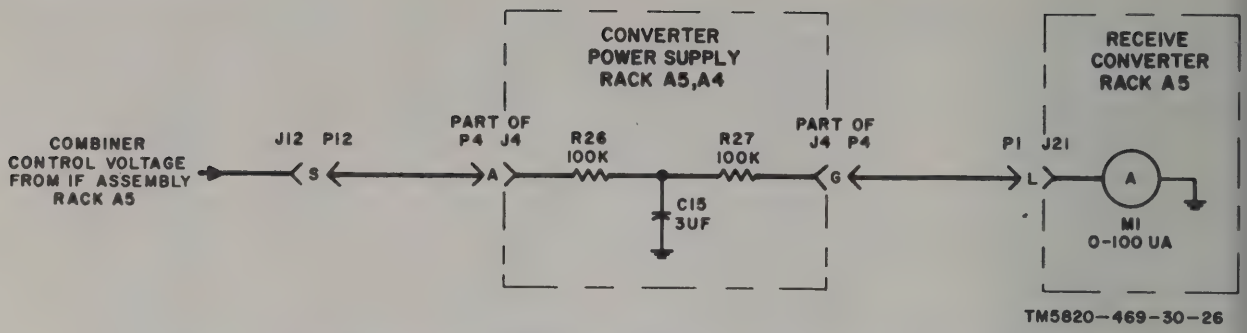


Figure 8. Combiner-control voltage distribution rack A5, simplified schematic diagram.

(7) The V4A plate voltage increase raises the Zener potential of CR3, and the diode conducts; this permits a positive voltage to be developed across R29.

(8) The positive voltage across R29 is applied to the base of Q1 through R30. This action causes Q1 to conduct.

(9) When Q1 conducts, the internal resistance of Q1 drops and the combiner-control input signal to V4B is shunted to ground.

(10) The point at which the signal is shorted to ground is determined by setting COMBINER THRESHOLD ADJUST potentiometer R28 to the desired value (normally 2 db below threshold).

e. Combiner-Control Voltage Shaper V4B Output Circuit. The output of V4B, taken from the cathode, is applied through R3 to pin 5 of jack J5, and through R1 to pin 7 of jack J5. From pin 5 of J5, the output signal is routed to the discriminator-combiner module and to 8-mc IF amplifier No. 2. The output from pin 7 of J5 is routed to the metering circuit of the receive converter (fig. 161). The output voltages are filtered by capacitors C2, C7, and C11. For distribution of the combiner-control voltage in rack A4, refer to figure 7; and for distribution in rack A5, refer to figure 8. For additional circuit details on the combiner-control voltage development, refer to paragraphs 118 and 119. Refer to paragraph 127 for functional details of the combiner-control voltage application during diversity operation.

f. Output Impedance Control Circuit. Transistor Q2 and Zener diode CR4 in the cathode circuit of V4B provide a high impedance which varies directly with the voltage applied. Resistor R32 is a voltage-dropping resistor for Zener diode CR4.

g. Combiner Balance Test Circuit. When COMBINER BAL TEST switch S1 is depressed, 6.3 volts ac is applied through coupling capacitor C30 to the control grid of V4B for adjustment of COMBINER BALANCE control R27 in discriminator-combiner A5.

h. Minor Components. Resistor R31 and capacitor C38 form a plate-decoupling network for V4B. Plate decoupling for V4A is performed by R25 and C37. The cathode voltage of V4A is established by a voltage divider consisting of R25, R27, and R28 connected between the 200-volt dc supply and ground. Resistor R26 serves as the plate load resistor for V4A.

115. Bandwidth Control Module A2 Filter Networks (fig. 165)

This network filters the filament voltage, the plate supply voltage, and the input and output control voltage. Capacitors C4 and C9 and choke L5 filter the plate supply; capacitors C5 and C10 and choke L3 filter the filament supply. The filters for the input and output control voltages are capacitors C1, C2, C3, C6, C7, C8 and C11 and chokes L1 and L4.

Section IV. IF MODULES A3 AND A4

116. General

IF modules A3 and A4 process the 8-mc IF signal to maintain minimum amplitude variations and provide amplification of the IF signal. The IF modules also provide control voltages to bandwidth module A2 for controlling the combining circuits in discriminator-combiner module A5. A metering circuit is provided for monitoring the control voltages, the IF gain, and the current of an external crystal circuit. The detailed circuit function of the IF modules is covered in paragraphs 117 through 121.

117. IF Signal Amplification (figs. 166 and 167)

Limiter amplifiers V1 through V4 of IF modules A3 (8-mc IF amplifier No. 1) and A4 (8-mc IF amplifier No. 2) are similar in operation. The circuit function described in *a* and *b* below covers limiter amplifier V1 of module A3. However, since V1 through V4 of both modules differ only in the development of a control voltage for V4 (para. 114) in the bandwidth control module, *a* and *b* below apply to V1 through V4 in both IF modules. When the 8-mc IF signal from bandwidth module A2 is normal in signal strength, the limiter amplifiers function as cathode followers (section A of the tubes) driving grounded-grid amplifiers (section B of the tubes).

a. Cathode Follower V1A. The 8-mc IF signal output of bandwidth control module A2 is applied to IF module A3, through jack J2 (fig. 166). The signal is coupled, through C1 and parasitic suppressor resistor R42, to the grid of V1A. The output signal of cathode follower V1A is developed across parallel cathode resistors R1 and R2 and coupled direct to the cathode of V1B. The grids of V1A and V1B are maintained at a positive potential (in respect to ground) by a voltage-divider network consisting of resistors R5 and R9 and isolating resistor R4. The grid circuit of V1B, consisting of resistor R8 and capacitor C7, is a low-impedance path to ground at the IF frequency.

b. Grounded-Grid Amplifier. The output of cathode follower V1A is applied to the cathode circuit of grounded-grid amplifier V1B. The amplified output of V1B is coupled to the grid of the next stage through network Z1 and coupling capacitor C11. Network Z1 consists of a plate load parallel-tuned circuit (R1, L1, and C1), a series-tuned coupling circuit (C2, C3, L2, and L3), and part of an input parallel-tuned circuit (R2, L4, and capacitor C41, which is external to Z1). Network Z1, together with C41, is tuned to the center frequency of 8 mc and has a bandwidth of approximately 7.6 mc.

Note. The overall bandwidth of each IF module is less than 7.6 mc due to the effect of bandwidth reduction when several tuned circuits are operating together.

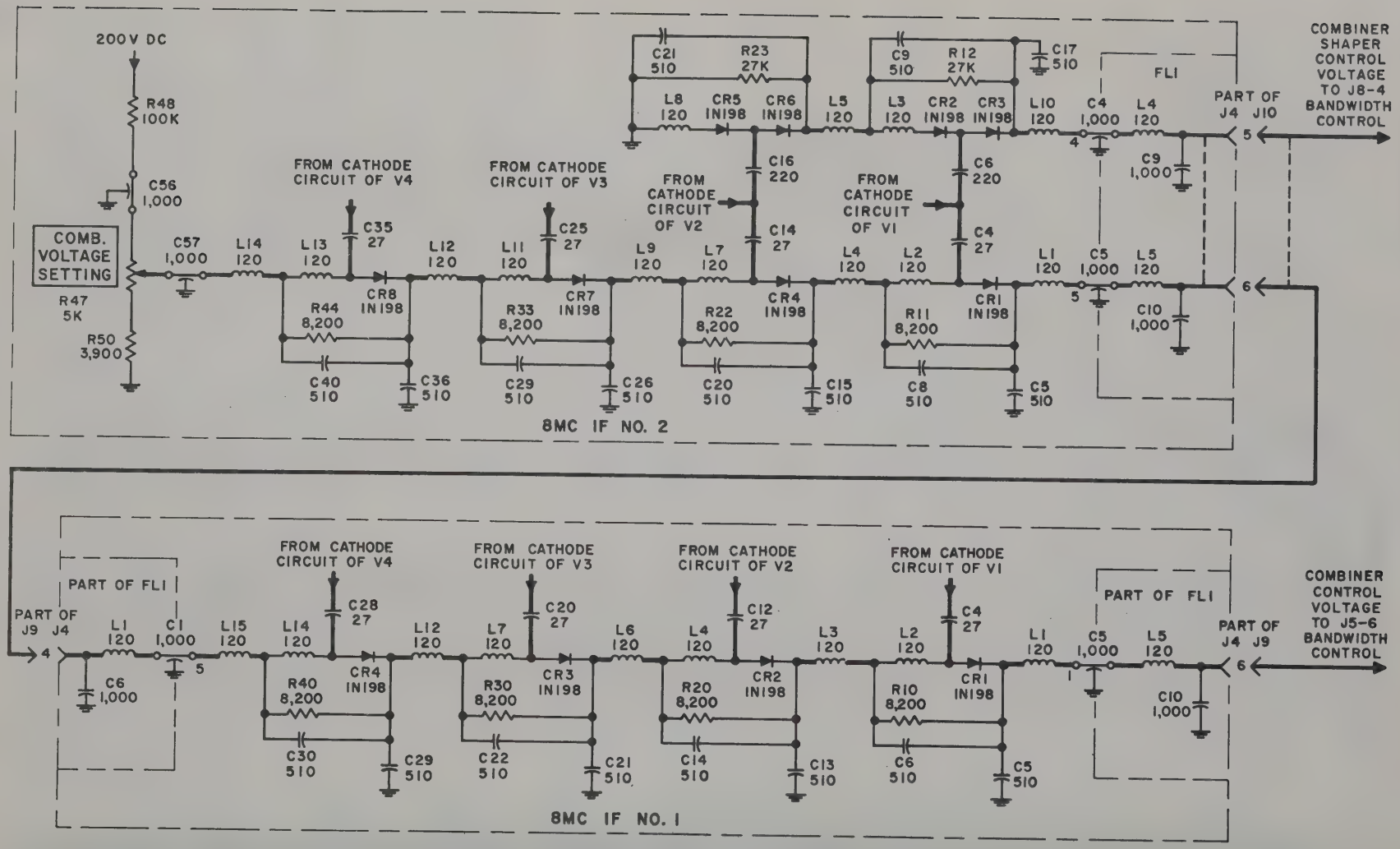
c. Output Network Z4. Networks Z2 and Z3 are identical with Z1. Network Z4, together with capacitor C44 (module A3) or capacitor C53 (module A4, fig. 167), is tuned to 8 mc and has a bandwidth of approximately 7.6 mc. The output of network Z4 of module A4 is applied to coupling capacitors C42 and C43. Capacitor C42 couples the 8-mc signal, through jack J2, to limited amplifier V1 in discriminator-combiner module A5 (para. 123). Capacitor C43 couples the output signal to jack J3, through a detector circuit consisting of diode CR9, resistor R45, and capacitor C41. This dc voltage is applied to J3 and is used for monitoring purposes.

d. Detector Circuit. The output signal of each IF stage in both IF modules is applied to a detector circuit. The function of this circuit is explained in paragraph 118.

118. Combiner-Control Detector Circuit (figs. 9 and 190)

Each of the two 8-mc IF amplifier stages has a 1N198 diode detector connected in the cathode circuit. The eight detectors are connected in series. This detector circuit derives the combiner-control voltage.

a. Circuit Operation. The pedestal level of detectors CR1 through CR4, located in 8-mc IF amplifier No. 1, and detectors CR1, CR4, CR7, and CR8, located in 8-mc IF amplifier No. 2, is established by the setting of COMB. VOLTAGE SETTING control R47. Capacitors C5, C15,



NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. COMPONENTS NOT ENCLOSED IN AN ASSEMBLY ARE PART OF THE CABINET
3. ☐ INDICATES EQUIPMENT MARKING

TM5820-469-30-27

Figure 9. Detector circuit, simplified schematic diagram.

C26, C36 (located in 8-mc IF No. 2), C5, C13, C21, and C29 (located in 8-mc IF amplifier No. 1) charge through the diode detectors to the level set by control R47. When the 8-mc input signal increases in amplitude, the change is coupled to the detector. On the positive swing of the signal, the diodes conduct and the above capacitors charge to the new level. When the amplitude of the input signal decreases, the capacitors discharge to the new level, but never below the level set by control R47. The output of this detector circuit (combiner-control voltage) is applied to pin 6 of jack J5 on bandwidth control module A2, and from there to the grid of V4B.

b. Module A3 Filter Network. Filtering for the combiner-control voltage developed by the detector in 8-mc IF amplifier No. 1 is accomplished by chokes L1, L2, L3, L4, L6, L7, L12, and L14, capacitors C6, C14, C22, and C30, and resistors R10, R20, R30, and R40.

c. Module A4 Filter Network. Filtering for the control voltage developed by the detector in 8-mc IF amplifier No. 2 is accomplished by chokes L1, L2, L4, L7, L9, L11, L12, L13, and L14, capacitors C8, C20, C29, C40, and C57, and resistors R11, R22, R33, and R44.

119. Voltage-Doubler Circuit
(fig. 9)

a. General. Detector circuits are connected to the cathode circuits of the first two amplifier stages in the 8-mc IF amplifier No. 2 module. These two detector circuits are arranged as voltage doublers and connected in series. The positive voltage developed by the two detectors is used to control the operation of the combiner-control voltage-shaping circuit located in the bandwidth control (para. 114*b*).

b. Circuit Function. The 8-mc IF signal developed in the cathode circuit of V1 and V2 is coupled to the doubler circuit by coupling capacitors C6 and C16. Diodes CR2 and CR3, together with a filter circuit consisting of L3, C9, and R12, comprise a doubler circuit in the cathode of V1; the voltage-doubler circuit (CR5 and CR6) in the cathode circuit of V2 performs the same function. The output of the two doubler circuits is connected in series and charges capacitor C17 to the peak-to-peak value of the input 8-mc IF signal. The positive voltage developed across capacitor C17 is coupled to pin 5 of jack J4, through choke L10 and the filter circuit located in FL1. This voltage is applied to the grid of V4A in the bandwidth control.

120. Filter FL1
(figs. 166 and 167)

Both IF modules (A3 and A4) contain a filter network which provides additional filtering for the plate supply voltage, filament supply voltage, and detected signal voltage. These filters remove high-frequency components and prevent undesired interstage coupling. Filter FL1 located on 8-mc IF No. 1 contains five capacitor input filters. Filter FL1 located on 8-mc IF No. 2 contains seven capacitor input filters.

121. Filament Circuit Filters
(figs. 166 and 167)

Filtering for the filament voltage applied to 8-mc IF amplifier No. 1 is accomplished by chokes L8 through L11 and capacitors C37 through C40. Filtering for the filament voltage applied to 8-mc IF amplifier No. 2 is accomplished by chokes L15 through L18 and capacitors C44 through C47.

Section V. DISCRIMINATOR-COMBINER MODULE A5

122. General

The discriminator-combiner demodulates the frequency-modulated 8-mc IF signal and amplifies the audio signal for application to the multiplexer. When two receivers are used for diversity operation, the audio output signals of the two receivers are combined in this module. The combined signal output is equal to the signal level of either receiver alone; the combined noise output is *less* than the noise output of either receiver.

123. Limiter Amplifier V1
(fig. 168)

The 8-mc IF fm signal from IF module 2A4 is applied to the grid of limiter amplifier V1, through jack J1, coupling capacitor C1, and suppressor R1. Limiter amplifier V1 is identical with the limiter amplifiers in IF modules A3 and A4 (para. 117). With normal level input signals, the circuit acts as a cathode follower driving a grounded-grid amplifier. When the signal input is large, the circuit limits or clips the positive and negative signal peaks. This limiting action removes amplitude modulation (noise) from the fm signal. The output-coupling circuit, consisting of network Z1 and capacitor C7, is identical with that described in paragraph 117*b*. When required, an 8-mc test signal may be applied to the limiter amplifier cathode circuit from oscillator Q4 (para. 130).

124. Amplifier V2
(fig. 168)

The amplified 8-mc IF signal voltage from V1 is applied to the control grid of amplifier V2, through coupling capacitor C8. The grid is biased by a voltage divider consisting of resistors R11 and R12. Cathode bias is furnished by R14 and C38. The amplified output of V2 is inductively coupled to the discriminator circuit by transformer T1. The output signal is also coupled to test pack J10 through C42 and a detector circuit consisting of diode CR4, resistor R50, and capacitor C43.

125. Discriminator V3
(fig. 168)

Discriminator V3 is a Foster-Seely-type circuit which consists of a tuned circuit, rectifier V3, and associated components. The audio output is taken from OUTPUT LEVEL control R31. The primary and secondary of T1 are tuned to 8 mc by variable capacitors C11 and C14, respectively. When the input frequency from amplifier V2 is exactly 8 mc, the output voltage is zero. When the input frequency is less than the resonant frequency, the resultant voltage is negative. When the input frequency is greater than the resonant frequency, the resultant voltage is positive. The audiofrequency out signal across OUTPUT LEVEL potentiometer R31 is applied to the grid of phase splitter V4A, through coupling capacitor C18. Test jack J9 is used for monitoring the output during discriminator zero adjustments.

126. Phase Splitter V4A
(fig. 168)

a. Phase splitter V4A receives the audiofrequency (AF) signal from the discriminator and produces two af signals equal in amplitude and 180° out of phase. The outputs are used to drive each section of combiner tube V5.

b. The discriminator output is applied to the control grid of V4A. Two outputs of approximately equal amplitude are obtained by the use of a plate load resistor and a cathode resistor of approximately equal value. An output signal in phase with the input signal is developed in the cathode circuit across cathode resistors R21 and R22. This output is applied to combiner V5A through coupling capacitor C20 and isolation resistor R25. This output is also applied to jack J5 (not used when this equipment is part of the Pershing Weapons System) through resistor R23. The plate output signal 180° out of phase with the input signal, is developed by plate load resistor R20 and applied to combiner V5B, through coupling capacitor C19 and isolation resistor R24.

127. Diversity Combiner V5
(fig. 168)

a. General. A tropospheric scatter receiver terminal normally uses two receivers, each connected to a separate antenna, for diversity reception. A combiner output stage, which is essentially a cathode follower, is included in each receiver. The combiner output stages are connected in parallel to produce the combined output signal. This combined signal, consisting of both the signal components and random noise components, is applied to a common load. An improvement of up to 3 db over the equal signal-to-noise ratios of the individual receivers is possible in the composite output.

b. Combiner Circuit. The combiner circuit consists of tube V5, transistors Q1 and Q2, Zener diode CR1, and associated circuit com

ponents. The AF inputs to combiner V5 from phase splitter V4A are applied to the grids of V5B and V5A, through coupling capacitors C19 and C20 and isolating resistors R24 and R25. The output of V4 (para. 114) of bandwidth control module A2 is applied in phase to the grids of V5 through COMBINER BALANCE potentiometer R27 and grid resistors R-26 and R28. The combiner control voltage is a positive dc potential plus an ac component that varies proportionately with the fade cycle of the rf input signal. Combiner V5A and V5B are connected as cathode followers. The cathode circuit of V5B contains transistor Q1 and emitter resistor R29. Emitter-to-base bias and emitter-to-collector current of Q1 is maintained at a constant level by Zener diode CR1 and resistor R18. As a positive signal is applied to the grid of V5B, the internal resistance of V5B decreases. With the bias voltage of Q1 held constant, the collector current does not increase appreciably with an increase in collector voltage. The impedance of Q1 remains constant as the resistance of V5B decreases. Since V5B and Q1 are in series across the 190-volt supply, the voltage across Q1 (collector to ground) increases. Any voltage variation applied to the grid of V5B is reflected in a cathode potential variation. This cathode variation is coupled, through capacitor C21, to the grid of differential amplifier V6A. Combiner V5A functions in an identical manner as V5B with its output being applied to V6B.

c. Diversity Combining. Diversity combining is accomplished when the combining circuits of two receivers are connected in parallel with each other. Connecting jack J2 to J2 of an equivalent receiver combiner circuit, and jack J3 to jack J3 of the other receiver combiner circuit arranges the combiner circuits in parallel. The signal outputs of the combiners are connected together, and the larger signal levels are coupled to differential amplifier V6 (para. 128).

128. Differential Amplifier V6
(fig. 168)

a. General. The output from each half of V5 contains the modulation component (AF) and an ac noise component varying rapidly at a rate determined by the undesired combiner-control signal (RF signal level). These signals are coupled to the two halves of differential amplifier V6. To function properly and give maximum cancellation of the undesired combiner control noise voltage, the signals applied to each grid of V6 must be exactly of equal amplitude and maintain the same phase relationship. Large coupling capacitors, C21 and C23, maintain the desired phase relationship, and balance control R27 maintains equal amplitude.

b. Amplification of AF. The grids (pins 3 and 1) of V6 are placed at a positive potential by a voltage divider consisting of resistors R32 and R34. Capacitor C22 is a bypass capacitor. Resistors R33 and R35 are grid resistors. Cathodes (pins 2 and 8) are connected together and returned to ground through a high impedance provided by transistor Q3. This transistor circuit operates in the same manner as transistors Q1 and Q2 (para. 127*b*) and maintains a constant cathode impedance for V6 higher collector voltage does not increase collector current). When the grid of V6A is driven positive by the output signal of V5B, the signal from V5A coupled to the grid of V6B drives V6B negative by the same amount. The positive signal on the grid of V6A will cause the cathode potential to rise in the positive direction; however, the negative signal on the grid of V6B is simultaneously the cathode (pin 8) to go in a negative direction. The common cathode potential remains constant and tube V6 operates as an amplifier for the AF signal component (but not for the combiner control voltage). The amplified output, developed at the plate of V6A by plate load resistor R36, is applied to cathode follower V4B (para 129) through coupling capacitor C25. The output developed at the plate of V6B by plate load resistor R39 is not used. Zener diode CR3 maintains the plate supply voltage of V6 at a fixed potential. Capacitor C26 and resistor R40 provide plate decoupling.

c. Cancellation of Combiner-Control Signal. The combiner-control signal represents the fade cycle of the received signal, because it is de-

rived by sampling the signal level at the two 8-mc IF amplifier modules (para. 118). The grids of V6 are driven in phase by the combiner-control signal component. The combiner-control signal applied to the grids of V6 varies the cathode current through the common cathode circuit consisting of R38 and Q3. Since the cathode voltage is the product of the sum of both tube section currents, the cathode voltage variation is twice the value it would normally be with a single tube section. Since the cathode-to-ground voltage variation is always out of phase with the grid-to-ground voltage variation, the net grid-to-cathode potential on both tube sections is held constant because of the degenerative effect of the cathode circuit on the combiner-control voltage. (Note that the audio input signal (*b* above) applied to the two grids of V6 was out of phase and, in effect, produced no voltage change in the common cathode circuit.) This action results in the cathode circuit having a degenerative effect on the combiner-control voltage input and no effect on the desired audio signal. Since the combiner-control voltage is canceled by the degenerative effect of the common cathode circuit, no output is obtained for the combiner-control voltage variation, thereby minimizing the effect of the combiner voltage noise.

129. Cathode Follower V4B
(fig. 168)

Cathode follower V4B matches the output impedance of V6 to the impedance of transformer T2. The amplified AF signal from differential amplifier V6A is applied to the control grid of cathode follower V4B, through coupling capacitor C25. Grid resistor R41 is grounded through cathode resistor R43 so that only the signal voltage across R42 has a degenerative effect on the input signal. This action improves the response of the stage and permits handling of large amplitude signals. The output signal is developed across cathode resistors R42 and R43 and applied to transformer T2, through coupling capacitor C27. Transformer T2 matches the impedance of V4B to the 600-ohm output. The output signal is inductively coupled to jack J4. PHONE jack J7 is provided for monitoring when the discriminator-combiner module is being tested.

130. Test Oscillator Q4
(fig. 168)

Transistor oscillator Q4 produces an 8-mc signal which is used for test purposes. This oscillator is inoperative until BFO switch S1 is closed and a dc potential is applied to the circuit. Base and emitter potential is derived from a voltage divider consisting of resistors R48, R47, R46, and R44. Capacitors C36 and C37, and resistor R47 form a filter. Capacitor C34 is a decoupling capacitor. Crystal Y1 functions as an 8-mc series-tuned circuit which provides a feedback path between the collector and base for the 8-mc signal. Inductor L4 and capacitors C32 and C33 form an 8-mc output tuned circuit. ZERO ADJ capacitor C32 compensates for circuit changes. The output voltage developed across the output tuned circuit is coupled through C31 to the cathode circuit of limiter amplifier V1. The oscillator signal and the incoming signal to the module are mixed in V1 and appear as an output from the discriminator. This signal is monitored at PHONE jack J7 to make certain that the transmitter and receiver are operating on the correct frequency.

131. Discriminator-Combiner Module A5 Filter Networks
(fig. 168)

a. Filter FL1. The plate supply voltage and ac and dc filament voltages are filtered by filter networks. These networks consists of chokes L1 through L5, and capacitors C1 through C3, C5 through C9, and C11. The combiner-control voltage is filtered by a network consisting of resistor R1 and capacitors C4 and C12.

b. Filament and Plate Circuits. The filament circuit is filtered by chokes L2 and L3 and capacitors C28 through 30. Interstage decoupling in the plate circuit is accomplished by resistors R9 and R30 and capacitors C2, C6, and C9.

Section VI. IF AMPLIFIER MAIN CHASSIS

132. General

The IF amplifier main chassis provides interunit wiring, power, and signal inputs and outputs for the modules of the IF amplifier, as well as mounting facilities. The main chassis contains no active circuit components.

133. Signal and Power Distribution (fig. 169)

Jack J12 provides ac and dc power to the IF amplifier and connects the tuning monitor output signal, the filtered combiner voltage output, and the balanced mixer crystal current to the external indicator and tuning circuits. Coaxial connectors J2, J3, J4, J5, and J6 provide the remainer of the IF amplifier outputs to the radio set. Jack J1 connects the 70-mc output of the receive converter to the input of the IF amplifier.

CHAPTER 8

FUNCTIONING OF RECEIVER POWER SUPPLIES

Section I. BLOCK DIAGRAM

134. General

Power Supply PP–3313/TRC–80 (IF power supply) provides the receiver with two 200-volt dc sources, a 190-dc source, and a —6.3-volt dc and a 6.3-volt ac source. Power Supply PP–3314/TRC–80 (converter power supply) provides a 200-volt dc source. The converter power supply also accepts a sample crystal current (4-kmc detector) input signal (0 to 0.1 volt dc) and processes the signal to provide a 0- to —30-volt dc delayed agc voltage for gain-control use in the receiver local oscillator circuits.

135. Block Diagram of Power Supplies

a. IF Power Supply (*fig. 10*). Primary power of 120 volts ac is applied to filament transformer T1, the —6.3-volt regulated power supply, and to time delay K1 through POWER switch S1. After a time delay of approximately 30 seconds, the primary power is applied through the closed contacts of time delay relay K1 to three identical 200-volt dc regulated power supply modules A1, A2, and A3. The 200-volt dc output of power supply A3 is coupled through voltage-dropping resistor R10 to provide an output of 190 volts dc.

b. Converter Power Supply (*fig. 11*).

(1) Primary power of 120 volts ac is applied through PWR switch S1 to filament transformer T1 and time delay relay K1. Filament transformer T1 provides filament power to amplifiers V1, V2, and V3, and a reference voltage to chopper assembly A2. After a time delay of approximately 30 sec-

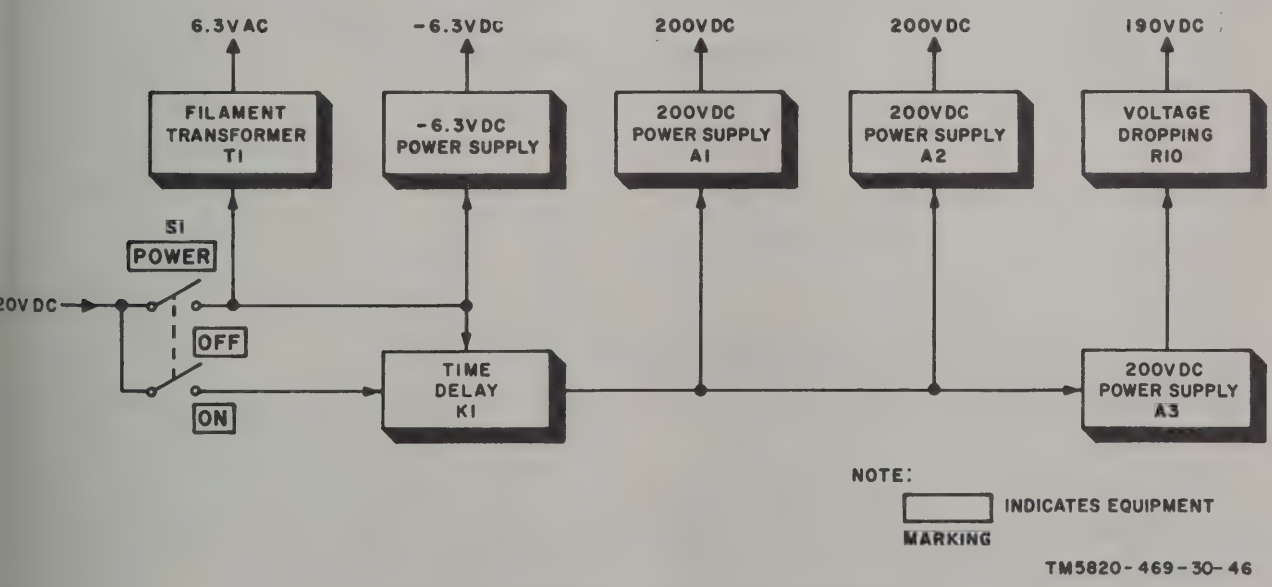


Figure 10. IF power supply, block diagram.

onds, primary power is applied to regulated power supply module A1. The power supply provides 200 volts dc to the plate circuits of amplifiers V1, V2, and V3 and to circuits in the receive converter. When INJ switch S2 is in the ON position, 200 volts dc is provided to other units of the receive converter.

Note. INJ switch S2 is a spring-return type. Momentarily holding this switch at OFF produces non-diversity reception as a test to quickly determine the presence or absence of diversity improvement once a scatter circuit has been established.

(2) The crystal current (developed by the balanced mixer from the local oscillator signal in the receive converter) is applied through chopper assembly A2; ac amplifiers V1, V2, and V3A; threshold amplifier V3B; and a rectifier filter circuit to develop an agc control voltage of 0 to —30 volts dc. Chopper assembly A2 produces a square-wave signal that varies at a rate equal to the frequency of the filament voltage (same as primary power). The square-wave output is amplified by ac amplifiers V1, V2, and V3A. The output of V3A is limited and rectified in the grid circuit of threshold amplifier V3B. The output of threshold amplifier V3B is coupled through a voltage-doubler circuit and applied as a local oscillator agc voltage to the receiver oscillator unit.

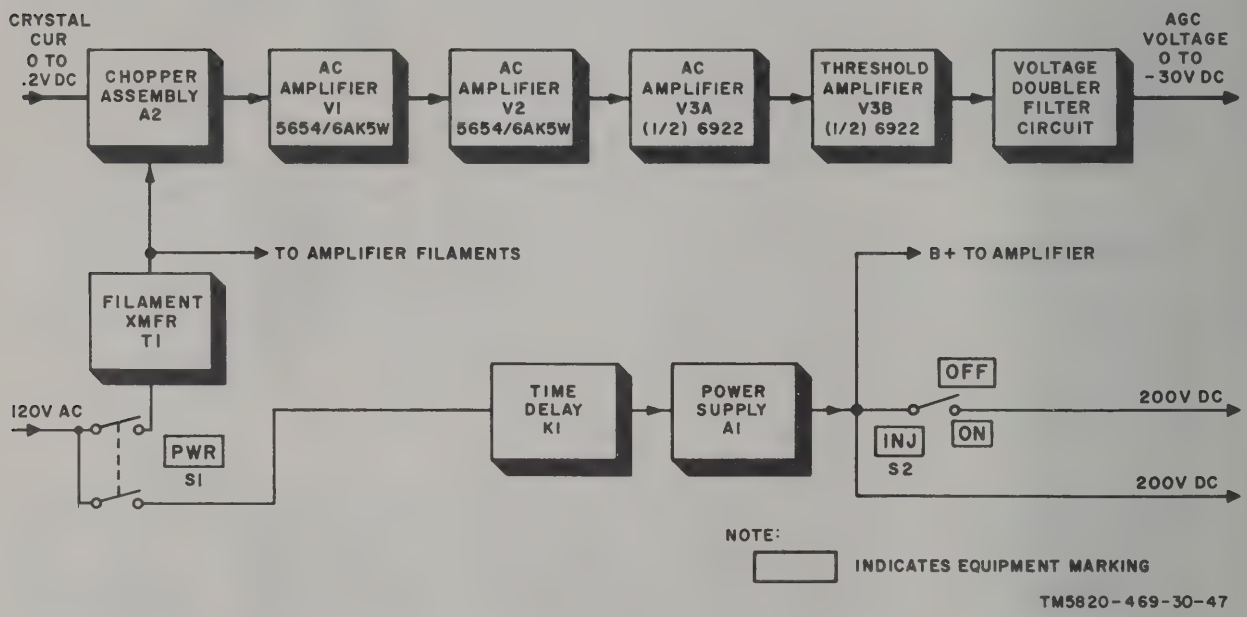


Figure 11. Converter power supply, block diagram.

Section II. CIRCUIT FUNCTION

136. IF Power Supply
(fig. 170)

a. Input Circuit. Primary power of 120 volts ±12, single phase, 47 to 420 cps, unregulated, is applied through jack J5 and fuses F1 and F2 to POWER switch S1. Operating POWER switch S1 to the ON position applies power through fuse F7 to transformer T2, POWER lamp DS1, and series voltage-dropping resistor R1. Primary power is also applied through fuse F3 to filament transformer T1 and the heater of time delay relay K1. Upon completion of the time delay required to acti-

vate relay K1, primary power is applied through relay K1, to fuses F4, F5, and F6 to 200-volt power supply modules A1, A2, and A3. When relay K1 is activated, TIME DELAY lamp DS2 is lighted. Terminal board TB1 provides facilities for application of regulated primary power when required.

b. Filament Circuit. Transformer T1 provides an output power of 6.3 volts ac, at 10 amperes, for tubes in the IF amplifier. The output of filament transformer T1 (terminals 5 and 6) is available between pins D and E and C and F of jack J5.

c. Regulated —6.3-Volt Dc Power Supply. The secondary winding of transformer T2 (terminals 5 and 7) is connected across a bridge rectifier consisting of rectifiers CR2 through CR5. The rectified output is applied across filter capacitor C1, through resistor R9, and across Zener diode CR1. Diode CR1 and resistor R9 maintain a constant output voltage. The —6.3-volt regulated dc output is connected to jacks J4 (white) and J5 (pin J).

d. Power Supplies A1, A2, A3. Power supplies A1, A2, and A3 are identical and are also used in other units of the AN/TRC–80. Refer to paragraph 48 for detailed circuit function.

e. Output Circuits.

(1) *Power supply A1.* The output of power supply A1 is applied to voltage-divider network R3 and R4. Indicator lamp A1 (DS3), connected across resistor R3, indicates that power output is available. Fuse F8 protects the power supply output circuit and prevents excessive loading. Jack J1 provides a convenient test point.

(2) *Power supply A2.* The power supply A2 output circuit is identical with that of power supply A1.

(3) *Power Supply A3.* The power supply output circuit is similar to that of power supplies A1 and A2. Series resistor R10 provides a 10-volt decrease in the output voltage. Capacitor C2 provides additional RF decoupling. Resistor R11 is a bleeder resistor that stabilizes the load on the power supply.

137. Converter Power Supply (fig. 171)

a. Input Power Circuit. Primary power of 120 volts ±12, single phase, 47 to 420 cps, unregulated, is applied through jack J4 and fuses F1 and F2 to PWR switch S1. Operating PWR switch S1 to the ON position applies power through fuse F4 to transformer T1, PWR lamp DS1 and series resistor R30, and the heater of time delay relay K1. PWR switch S1 also connects the primary power to terminals V and S of jack J4. Upon completion of a time delay required to activate time delay relay K1, primary power is applied through relay K1 and fuse F5 to transformer T101 and to TD lamp DS2 and resistor R31. Terminal board TB1 provides facilities for application of regulated primary power when required.

b. Power Supply A1. Power supply A1 is identical with those used in other units of the radio set. Refer to paragraph 48 for detailed circuit function.

c. Power Supply A1 Output Circuit. The output of power supply A1 is applied to voltage-divider network R32 and R34 that is used to limit the voltage applied to PWR SUP lamp DS3. Fuse F3 protects the power supply output circuit and prevents excessive loading. The output voltage of the power supply is applied to jack J1; pin L of jack J4; plate circuits of amplifiers V1, V2, and V3; and to INJ switch S2.

d. INJ Switch S2 Circuit. INJ switch S2 controls application of a dc voltage to INJ lamp DS4 and applies plate voltage to frequency tripler V4 in the multiplier unit (fig. 156) of the receive converter. During normal operation, spring-action INJ switch S2 is always set to ON. This action activates frequency tripler V4 and assures an input signal to the varactor multiplier (fig. 161). The varactor multiplier output is used as an injection signal for heterodyning with the received signal. When switch S2 is in the OFF position, plate voltage is removed from the frequency tripler, the input

signal to the varactor multiplier drops to zero, and the injection signal is removed, thereby disabling the receiver. The function of the S2 circuit components located in the receive converter power supply is covered in (1) and (2) below:

(1) When INJ switch S2 held is in the OFF position, INJ lamp DS4 is parallel-connected with capacitor C18 and series-connected with resistors R37 and R38, forming a relaxation oscillator circuit. Resistor R37 and R39 form a voltage-divider network across the power supply. Capacitor C18 charges to the voltage across R39 through resistor R38. When the capacitor voltage reaches the firing potential of lamp DS4, the lamp ionizes and allows capacitor C18 to discharge. Lamp DS4 flashes on and off (warning the operator that the receiver is disabled) at a rate determined by the values of R37, R38, and C18.

(2) When INJ switch S2 is in the ON position, voltage-divider network R35 and R36 is connected across the power supply output, and the B+ output is routed through pin X of jack J4, through the receiver converter main frame, to P3 on the multiplier unit (fig. 156). INJ lamp DS4 is connected across R36 and indicates presence of the output voltage.

e. Filament Circuit. The filaments of amplifiers V1, V2, and V3 are connected in a series-parallel arrangement, with resistor R33 across the secondary of transformer T1. The output of transformer T1 is also applied to the chopper circuit (*f* below).

f. Chopper Circuit. The chopper circuit consists of a chopper balance network and chopper assembly A2.

(1) A crystal current signal (whose amplitude depends upon the local oscillator signal level detected in balanced mixer A8 (fig. 161)), 0 to —0.1 volt dc, is applied to chopper assembly A2 through pin D of jack J4. The dc input is applied through filter network R5, R6, and C1 to diodes CR2 and CR3.

(2) When the voltage at terminal 5 of T1 goes positive, diodes CR2 and CR3 conduct. This causes the junction point between R6 and C2 to appear as a low impedance to ground, shorting the dc input signal to ground. When the voltage at terminal 7 of T1 goes positive, diode CR1 conducts, but diodes CR2 and CR3 present a high impedance to the dc signal at the junction point between R6 and C2. The alternate shorting of the junction point between R6 and C2 to ground causes the voltage at this point to appear as a square wave that is coupled through C2, developed across R7 and C20, and applied to the grid of V1. The frequency of the square wave is equal to the line frequency of the primary power applied to T1. The network consisting of CHOPPER BALANCE potentiometer R1, resistors R2, R4, R40 through R43, and capacitor C17; prevents ac voltage of transformer T1 from appearing at the output (the junction point between R6 and C2).

g. Amplifiers V1, V2, and V3A. The output from the chopper circuit is applied to the control grid of V1. Resistor R7 on chopper assembly A2 is the grid-leak resistor for V1. Capacitor C20 on the chopper assembly shunts high-frequency components of the chopper circuit output to ground. The output of V1 is coupled to the grid (pin 1) of V2 through C3 and R3. Capacitor C21 shunts to ground any high-frequency component remaining in the signal. The output of V2 is coupled to the control grid of V3A through C8. The output of V3A is coupled to threshold amplifier V3B through C10. The amplifier cathodes are unbypassed to provide cathode degeneration for gain stabilization. The following chart indicates the remaining amplifier parts and their function.

Component	Function
R10, R15, R45	Cathode resistor.
R7, R12, R17, R20	Grid-leak resistor.
R11, R16	Screen-grid voltage-dropping resistor.
R9, R14, R19	Plate load resistor.
R8, R13, R18	Plate-decoupling resistor.
R3	Grid-limiting resistor.
C3, C6, C9	Plate-decoupling capacitor.
C4, C7	Screen-grid bypass capacitor.
C2, C5, C8, C10	Coupling capacitor.

h. Threshold Amplifier V3B. Threshold amplifier V3B remains cut off until the input signal from amplifier V3A exceeds a predetermined value. Zener diode CR4, in the cathode circuit of V3B, biases the tube to 8 volts and determines the threshold voltage. Zener diode CR8, in the grid circuit of V3B, prevents low-amplitude signals from being applied to the grid of V3B. When the input signal from V3A increases in the positive direction, the breakdown voltage of CR8 is exceeded and the signal is applied to grid resistor R20 and high-frequency shunt capacitor C23. When the grid-to-cathode voltage exceeds 8 volts, the signal is amplified by V3B and applied to a voltage-doubler circuit (*i* below). Plate decoupling is provided by R21 and C11.

i. Voltage-Doubler Circuit. The output signal voltage from V3B is doubled by voltage-doubler action and applied across R23 and filter capacitor C13. The voltage-doubler circuit consists of capacitor C12 and diodes CR6 and CR7. Capacitor C13 maintains the output voltage at a steady dc potential for slight signal variations. The voltage across C13 is applied to voltage divider R25 and R44, to J3, and to pin N of J4. The voltage across R44 is applied to a monitoring circuit through pin W of J4.

CHAPTER 9

FUNCTIONING OF ELECTRICAL FREQUENCY SYNTHESIZER O–937/TRC–80

Section I. BLOCK DIAGRAM

138. General

a. Synthesizer, Electrical Frequency 0–937/TRC–80 (synthesizer) is a self-contained frequency standard that supplies stable output frequencies between 22.6375 and 32.1250 mc. By means of selector switches, 1,000 discrete frequencies are available in 12.5-kc increments.

b. Three synthesizers are used in each AN/TRC–80. The function of these synthesizers, with respect to the other units of the radio set, is covered in paragraphs 54, 55, and 56 in TM 11–5820–469–20.

c. The synthesizer consists of three oscillators, two mixers, and the main chassis that contains the power supply and metering circuit. The outputs of oscillators No. 1 and No. 2 are mixed in mixer No. 1. The sum frequency is selected and amplified by mixer No. 1 and applied to mixer No. 2. The output of oscillator No. 3 is also applied to mixer No. 2 and the sum of the two input frequencies is selected and amplified. This generating and mixing action makes possible the selection of any one of 1,000 crystal-controlled frequencies at the output. Block diagram coverage of each module is provided in paragraphs 139 through 144.

139. Oscillator No. 1
(fig. 172)

Any one of ten crystals (Y310–Y319) can be selected by CHANNEL NO. UNITS selector switch S301. The selected crystal determines the output frequency of oscillator V301. Agc circuit, CR301 and CR302, stabilizes the output amplitude of the oscillator. The oscillator output frequency (F1) is variable from 325.0 to 437.5 kc in 12.5-kc increments and is applied to the input of mixer No. 1.

140. Oscillator No. 2
(fig. 172)

Any one of ten crystals (Y410–Y419) can be selected by CHANNEL NO. TENS switch S401. The selected crystal determines the output frequency of oscillator V401. Agc circuit, CR401 and CR402, stabilizes the output amplitude of the oscillator. The output of oscillator V401 is applied to buffer amplifier V402. Buffer amplifier V402 isolates oscillator V401 from loading effects of subsequent stages. The output signal amplitude of the buffer amplifier is held constant by agc circuit CR403 and CR404. The output frequency (F2) of oscillator No. 2, variable from 2.3125 to 3.4375 mc in increments of 125 kc, is applied to mixer No. 1.

141. Mixer No. 1
(fig. 172)

The outputs of oscillators No. 1 and No. 2 (F1 and F2) are mixed in balanced mixer V101. The balanced mixer applies the sum frequency (F1 + F2) to amplify V102 through three tuned circuits. Cascode amplifier V102 amplifies the signal and applies it to the input of amplifier V103 through three more tuned circuits. The six tuned circuits reduce the level of carrier F2, and the undesired mixer products, F2 + 2F1, at least 80 db below the level of desired signal, F1 + F2. An agc voltage, developed from the output of V103 by CR102 and CR103, is applied to the grid of V102 to maintain a constant output signal level. Ampli-

fier V103 is also a cascode amplifier and is similar to amplifier V102. The output frequency of V103 (F1 + F2), variable from 2.6375 to 3.8750 mc in increments of 12.5 kc, is applied to mixer No. 2.

142. Oscillator No. 3
(fig. 172)

Any one of ten crystals (Y710–Y719) can be selected by CHANNEL NO. HUNDREDS selector switch S701. The selected crystal determines the output frequency of oscillator Q702. Oscillator Q702, buffer amplifier Q701, and switch S701, with its associated parts, are mounted in a temperature-controlled oven. The output of oscillator Q702 is amplified by buffer amplifier Q701 and applied to the input of amplifier V751A. The output of V715A is amplified by V751B and applied to power amplifier V750. An agc control voltage, developed from the output of V750 by CR750 and CR751, is applied to the input circuits of V751A, V751B, and V750 to maintain a constant output signal level. The output of oscillator No. 3 (F3) is variable from 20 to 31.25 mc in increments of 1.25 mc and is applied as one of the inputs to mixer No. 2.

143. Mixer No. 2
(fig. 172)

The output of mixer No. 1 (F1 + F2) is mixed with the output of oscillator No. 3 (F3) in balanced mixer V201. The sum frequency (F1 + F2 + F3) is applied to the input of cascode amplifier V202 through circuits tuned to the desired frequency (F1 + F2 + F3). Cascode amplifier V202 amplifies the signal and applies it to the input of cascode amplifier V203 through circuits tuned to the desired frequency. Agc control voltage, developed from the output of V203 by CR202 and CR203, is applied to the grids of V202 and V203. The output frequency of V203 (output of mixer No. 2), variable from 22.6375 to 35.1250 mc in increments of 12.5 kc, is applied to other units of the AN/TRC–80.

144. Main Chassis
(fig. 172)

The main chassis of the synthesizer provides interconnecting facilities for the mixer and oscillator modules. The chassis also contains a self-contained power supply and metering circuit.

a. Power Supply. Primary power at 120 volts ac is applied through PWR switch S106. Time delay relay K601 allows for a time delay between amplication of filament power (6.3 volts ac) and application of high-voltage dc (200 volts dc) to the module circuits.

b. Metering Circuit. The metering circuit consists of meter selector switch S602 and meter M601. Switch S602 selects the signal level or agc level present in the selected oscillator or mixer module for application to M601.

Section II. OSCILLATOR NO. 1, CIRCUIT FUNCTION

145. Oscillator V301
(fig. 173)

Tube V301 and the associated circuit components comprise an electron-coupled crystal-controlled oscillator in which the screen grid functions as the anode for a crystal oscillator circuit. The oscillator output is electron-coupled to the plate circuit of V301.

a. Oscillator Circuit. The operating frequency of oscillator V301 is determined by crystals Y310 through Y319; capacitors C301 through C319, C322, C325; and inductor L301. The proper components for a given frequency are selected by CHANNEL NO. UNITS switch S301. The components not in use for a given frequency are switched out of the circuit and grounded through the rear contacts of switch S301. One side of the crystal circuit is coupled from switch S301A (front) to the grid of V301 through capacitor C331. The other side of the crystal is connected by switch S301B (front) to the screen grid of V301 through capacitor C324. The oscillator feedback signal is developed across the screen-grid tuned circuit consisting of L301 and C301 (with S301 in the position shown in figure 173) and C322. This

22: 6375 – 32.1250
1000 12.5khz steps

Osc 1 325 - 437.5
tube in 12.5 khz steps

Osc 2 2, 3125 to 3.4375
Tube 125khz steps

Osc 3 20 - 31.25
transistor 1.25 mhz steps

Balanced mixer

Input 120V 60hz

Each section has
AGC

					LABOR		
TIME STARTED AM PM	TIME FINISHED AM PM	HOURS	RATE PER HOUR		SALES TAX		
SERVICEMAN		DATE COMPLETED / /			TOTAL AMOUNT		

SERVICE ABOVE SATISFACTORILY COMPLETED

A finance charge is computed on a periodic rate of 1½% per month which is an annual percentage rate of 18% on any previous balance not paid within 30 days.

signal is fed back to the control grid of V301 through the selected crystal and associated variable capacitor. The tuned circuit in the screen grid is tuned below the resonant frequency, and it appears as a capacitive reactance to the oscillator frequency. This presents the proper phase and gain to sustain crystal-controlled oscillation. Cathode bias is furnished by R305. Capacitor C329 is the cathode bypass capacitor. Voltage-divider circuit R307 and R308 provides a fixed screen-grid voltage.

b. Amplifier Circuit. The oscillator signal is electron-coupled to the plate of V301 and drives the tank circuit consisting of C326 and the primary of T301. Capacitors C327 and C328 and resistor R306 make up an RF decoupling network. Capacitor C326 bypasses harmonics of the desired oscillator frequency. Signal output (325.0 to 437.5 kc) is coupled through T301 and applied to connector P301 through attenuator pad R309, R310, and R311. The output is also applied through rectifier diode CR303 and filter capacitor C330 to connector P302 for monitoring purposes.

146. Oscillator V301 Agc Circuit
(fig. 173)

The plate voltage variations of V301 are applied through capacitor C323 to an agc circuit that is used to control the oscillator output level. The agc circuit consists of a rectifier circuit, a biasing network, an output circuit, and a monitoring network.

a. The rectifier circuit consists of capacitor C323, diodes CR301 and CR302, and load resistor R301. Voltage divider R301 and R302 applies a reverse bias to diode CR301. Capacitor C320 and C328 bypass any RF variations to ground.

b. When the oscillator signal (plate voltage of V301) swings in a positive direction and exceeds the fixed bias on diode CR301, the diode conducts and allows capacitor C323 to charge to the new value. As the signal swings in the negative direction, capacitor C323 discharges through CR302 and resistor R303 to ground and, at the same time, charges capacitor C321. The voltage developed across R303 and C321 increases the bias and decreases the gain of V301. The agc voltage across C321 is routed through isolating resistor R312 and connector P302 to the metering circuit.

Section III. OSCILLATOR NO. 2, CIRCUIT FUNCTION

147. Oscillator V401
(fig. 174)

a. Frequency Selection. Oscillator V401 produces an output frequency variable from 2.3125 to 3.4375 mc in increments of 125 kc. The operating frequency of oscillator V401 is determined by crystals Y410 through Y419 and capacitor C410 through C419. The proper components for a given frequency are selected by CHANNEL NO. TENS switch S401. The crystals not in use are switched out of the circuit and grounded through the front contacts of switch S401B. The crystals and switch S401B are contained in a temperature-controlled oven assembly.

b. Oven Assembly. The oven assembly is heated by heating resistors HR401A (fast warmup) and HR401B (sustaining heater). OVEN lamp DS401 is lighted when power is applied to the sustaining heater. Thermostat switches S402, S403, and S404 are normally closed snap-action switches. Switch S402 is an emergency cutout switch and opens if the oven temperature exceeds 90° C (194° F). Switches S403 and S404 operate to control the oven assembly temperature by connecting and disconnecting power to resistors HR401A and HR401B, respectively. Switch S403 opens when the oven temperature rises to approximately 71±4° C (159±5° F). When the oven temperature rises to 78±3° C (172±5° F) switch S404 opens, removing power from lamp DS401 and heating resistor HR401B. Capacitor C428 is an arc suppressor for switch S404. Fuse F401 protects the primary power source

against oven assembly power circuit shorts. In normal operation, the oven cycles periodically on and aff (as indicated by DS401). Failure to operate usually indicates a faulty sustaining thermostat.

c. Oscillator Circuit. Tube V401 and the associated circuit components comprise an electron-coupled crystal-controlled oscillator in which the screen grid functions as the anode for a crystal oscillator circuit. The oscillator output is electron-coupled to the plate of V401. One side of the crystal circuit is coupled from switch S401A (rear) to the control grid of V401 and developed across voltage-divider network R401 and R402. The oscillator feedback signal is coupled from the screen-grid circuit to the grid circuit through capacitor C420. The feedback signal is applied to the selected crystal and an RF voltage-divider circuit consisting of capacitors C408 and C409 and inductor L402. The voltage developed across capacitor C409 is applied between the grid and cathode of V401 to sustain oscillations. Voltage-divider network R406 and R407 applies a fixed positive potential to the screen grid. Cathode bias is provided by R408 and C405.

d. Output Network. The oscillator signal is electron-coupled in V401, amplified, and developed across plate load inductor L401. Resistor R405 and capacitor C404 make up an RF decoupling network. The output of oscillator V401 is coupled to an agc circuit (*e* below) and to the grid circuit of amplifier V402 through coupling capacitor C407 and isolating resistor R410.

e. Agc Network. The oscillator agc network for oscillator No. 2 is similar to that used for oscillator No. 1. Refer to paragraph 146 for circuit function.

148. Amplifier V402
(fig. 174)

a. Input. The oscillator output signal from V401 is developed across resistors R409 and R416 and applied to the control grid of V402.

b. Output. Tube V402 amplifies the input signal. The output is developed across the primary of T401 and is coupled to output connector P401. The output of V402 is also coupled through C426 to an agc circuit for amplifier V402. The agc network maintains the output at P401 at a level that is determined by the diode bias voltage at the junction of resistors R417 and R418. The circuit operation of the amplifier agc circuit is similar to that described for V301 in paragraph 146. The output is also rectified by diode CR405, filtered by C427, and applied to the main chassis metering circuit through pin 3 of connector P402.

c. Minor components.

Component	Function
R412	Cathode-bias resistor.
C423	Cathode bypass capacitor.
R411 and C422	Plate-decoupling network.
R413 and R414	Screen-grid voltage-divider network.
C425	Screen-grid bypass capacitor.

Section IV. MIXER NO. 1, CIRCUIT FUNCTION

149. Balanced Mixer V101
(fig. 175)

a. F2 Input Circuit. The F2 input signal at P101 (2.3125 to 3.4375 mc, depending on the setting of oscillator No. 2) is developed across grid resistor R101 and applied to the grid of V101A. The signal at the plate of V101A is developed across a tuned circuit consisting of L101 and C102. The coupling between the two tube sections of V101 is through common cathode resistor R102.

b. F1 Input Circuit. The F1 input signal at P102 (0.325 to 0.4375 mc, depending on the setting of oscillator No. 1) is developed across grid resistor R103 and applied to the control grid of V101B.

c. Mixing Action. Mixing of the F1 and F2 signal takes place in V101B. The level of F2 is reduced at the plate of V101B by out-of-phase coupling between the plates of V101 through C103. The sum frequency (F1 + F2) at the output of V101B is applied to V102

through a triple-tuned circuit that is tuned to the sum frequency. The triple-tuned circuit output is coupled through C114 to the grid of cascode amplifier V102.

d. Minor Components.

Component	Function
R104 and C101	Plate-decoupling network for V101A.
R105 and C105	Plate-decoupling network for V101B.
L102, L103, L104	Part of triple-tuned circuit.
C106, C107, C109, C110, C112, and C113.	Part of triple-tuned circuit.
C108, C111, and C114	Coupling capacitors.

150. Cascode Amplifier V102 (fig. 175)

Cascode amplifier V102 is a dual triode that functions as a grounded cathode and grounded-grid amplifier.

a. Circuit Function. The output signal from balanced mixer V101 (para. 149) is developed across grid resistor R106 and applied to the grid of V102A. The input signal is amplified and is coupled from the plate of V102A to the cathode of V102B through C116. Grounded-grid amplifier V102B functions as the plate load for V102A. Cathode resistor R108 is unbypassed to isolate the cathode of V102B from ground. The output of cascode amplifier V102 is applied to cascode amplifier V103 through three loosely coupled circuits tuned to the signal frequency. The gain of V102 is controlled by an agc voltage (para. 151*b*) that is applied to the grid of V102A through R106.

b. Minor Components.

Component	Function
R107 and C115	V102A cathode-bias network.
R109, R110, and C117 through C119.	Plate-decoupling networks.
L105 through L107, and C120 through C127.	Components of triple-tuned circuit.
C138, C139, and R119	Agc filter.
C128	Interstage coupling capacitor.

151. Cascode Amplifier V103 (fig. 175)

Cascode amplifier V103 amplifies the input signal from V102 and couples the output through T101 and P104 to mixer No. 2. With the exception of the components listed below, cascode amplifier V103 is identical with V102 (para. 150).

a. V103B Cathode Circuit. Inductor L109 and resistor R113 are used to isolate the cathode of V103B from ground.

b. Agc Circuit. The output of V103 is also coupled to an agc circuit consisting of CR102 and CR103. This circuit is similar to that described in paragraph 146 except that the diodes are not biased. The output of the agc circuit is applied to the grid circuit of V102A through resistor R106 to maintain constant signal level output. The output of the agc circuit is also applied to a metering circuit through pin 2 of P103.

c. V103 Output Meter Circuit. The secondary voltage across T101 is rectified by CR101, filtered by C134, and applied to a meter circuit through P103.

Section V. OSCILLATOR NO. 3, CIRCUIT FUNCTION

152. Oscillator Q702 and Buffer Amplifier Q701 (fig. 176)

Transistors Q702 and Q701 comprise a crystal-controlled oscillator-buffer stage that drives amplifier V751A.

a. The operating frequency of oscillator Q702 is determined by crystals Y710 through Y719 and trimmer capacitors C710 through C719. The desired components are selected by switch S701. The oscillator output is developed across a tank circuit consisting of transformer T701, capacitor C709, and the components se-

lected by switch S701A (rear). One of the ten switch-selected crystals is connected to the emitter of Q702 through coupling capacitor C769 and provides crystal control of the oscillator. The emitter of Q702 is returned to ground through L701 and R708. The collector of Q702 drives the resonant tank circuit. A feedback signal from the tank circuit is coupled through capacitor C704 to the base of Q702 and also through C701 to the base of buffer amplifier Q701. The signal voltage (20 to 31.25 mc in 1.25-mc increments) applied to the base of Q701 is amplified and coupled from the collector through C702 to the primary of T750.

b. The operating voltage for transistors Q701 and Q702 is obtained from the B+ supply through R751, which drops the voltage to approximately 15 volts. Zener diode CR701 regulates this voltage, and inductors L704 and L753 and capacitors C706, C750, and C770 filter this voltage. Base bias for Q702 is derived from voltage divider R702, R703, R706, and R720. Base bias for Q701 is obtained from voltage divider R701, R705, and R706.

c. The oscillator and buffer amplifier components are contained in a temperature-controlled oven assembly. The oven assembly heater circuit is similar to that described in paragraph 147*b*. Capacitor C709 is a temperature-compensating device to minimize frequency drift during the warmup period.

d. The oscillator signal level is controlled by the collector currents of the two transistors. As the signal level increases, the collector current of Q702 and Q701 also increases. This, in turn, decreases the collector voltages, and provides an agc action which maintains a constant drive level that is applied to crystals Y710 through Y719.

153. Amplifiers V751A and V751B (fig. 176)

Amplifiers V751A and V751B are stagger-tuned amplifiers that amplify the output of buffer amplifier Q701 and drive power amplifier V750.

a. Circuit Function. The oscillator signal from transformer T750 is applied to the control grid of V751A. The amplified output of V751A is applied to the control grid of V751B through coupling capacitor C757. Tubes V751A and V751B are tuned to opposite sides of the pass-band center by inductors L750 and L751, respectively. This stagger-tuning broadens the response to include the required 11.25-mc range. The output of V751B is applied to V750 through coupling capacitor C760. The output level of V751 is maintained at a constant level by returning the grid circuits to the agc circuit (para. 155).

b. Minor Components. The function of the remaining components is listed below:

Component	Function
R753 and C753	Cathode-bias network for V751A.
R757 and C761	Cathode-bias network for V751B.
R754	Lowers Q of T750 secondary winding.
R752 and C751	Plate-decoupling network for V751A.
R758 and C758	Plate-decoupling network for V751B.
R755, R756, C752, C754, and C762.	Agc filter network.
R765	Grid resistor for V751B.

154. Power Amplifier V750 (fig. 176)

Power amplifier V750 is a twin triode connected in parallel. The output signal from V751B is applied to the two control grids. The common cathode circuit consists of resistor R760 and bypass capacitor C763. The output of V750 is coupled through T751 and C767 to output connector P751. The output is also coupled through C766 to rectifier diode CR752, filtered by L752 and C756, and applied to the meter circuit through pin 3 of connector P752. Plate decoupling is accomplished by C764, C765, and R761. The output of amplifier V750 is maintained at a constant level by returning the grids to the agc circuit (para. 155) through resistor R759.

55. Oscillator No. 3 Agc Circuit
(fig. 176)

The output of power amplifier V750 is applied through C768 to an agc circuit consisting of diode rectifiers CR750 and CR751; resistors R762, R763, and R764; and capacitor C755. The function of the agc circuit is similar to the agc network described in paragraph 146. The agc output voltage is developed across R762 and applied through a resistive-capacitive filter network to the grids of V750 and V751.

Section VI. MIXER NO. 2 AND MAIN FRAME, CIRCUIT FUNCTION

56. Balanced Mixer V201
(fig. 177)

The balanced mixer circuit consists of a dual triode with the input (F3, 20.0 to 31.5 mc) from oscillator No. 3 (para. 154) applied to V201A, and the input (F1 + F2, 2.6375 to 3.8750 mc) from mixer No. 1 (paras. 149–151) applied to V201B. The sum of the two inputs is selected by the triple-tuned coupling circuit between V201 and V202. The circuit is identical with balanced mixer V101 used with mixer No. 1. Refer to paragraph 149 for circuit function.

57. Cascode Amplifiers V202 and V203
(fig. 177)

a. Cascode amplifiers V202 and V203 amplify the output of balanced mixer V201 to produce the synthesizer unit output frequency. With the exception of the output circuit of V203B, cascode amplifiers V202 and V203 are identical with V102 and V103 used with mixer No. 1 (paras. 150 and 151).

b. The plate load for amplifier V203B is a tuned circuit consisting of L207, L215, C237, and C238. The tank capacitors are tapped to provide an output to connector P204. The output signal is also applied through coupling capacitor C239 to rectifier diode CR201, and through a filter network consisting of L211 and C240 to the meter circuit through pin 3 of connector P203. Plate voltage of V203B is applied to an agc circuit similar to that described in paragraph 146. The agc circuit maintains the mixer output at a constant signal level.

58. Synthesizer Unit Main Chassis
(fig. 178)

a. Power Circuits. Input power of 120 volts ac is applied to terminal board TB601. The jumpers between terminals 1 and 3 and between 2 and 4 may be removed when it is desired to operate the filament supply and the dc supply from separate sources. Chokes L601 through L604 and capacitors C601 through C604 provide RF filtering. Fuses F601 and F602 provide protection for the power supply and filament transformer T601. Input power is applied through PWR switch S601. Time delay relay K601 provides a 30-second delay of the application of power to the power supply when S601 is operated to ON. This condition allows the tubes in the modules sufficient time to reach the proper temperature. The dc power supply (A601) is identical with that used in other units and is covered in paragraph 48.

b. Output Filters. Filtering of the power supply output is provided by L605, C605, and C606. Chokes L606 through L610 prevent RF feedback to the power supply and between modules.

c. Meter Circuit. Meter M601, controlled by switch S602, monitors the outputs and agc voltage levels of the individual modules. Resistors R606, R607, R609, and R611 through R615 are current-limiting resistors.

d. Intermodule Filters. Signal interconnections between the modules are made with coaxial jumper cables. Chokes L611, L612, and L613 and capacitors C607 and C608 form a filter network between mixer No. 1 and the input of mixer No. 2. Chokes L614 through L617 and capacitors C609, C610, and C611 perform the same function between oscillator No. 1 and mixer No. 1.

CHAPTER 10

FUNCTIONING OF COMMUNICATION CONTROL PANEL SB–1564/TRC–80 AND ASSOCIATED TELETYPEWRITER CIRCUITS

Section I. INTRODUCTION

159. General

a. Communication Control Panel SB–1564/TRC–80 (control panel) provides patchboard functions for telephone and teletypewriter loop switching. The control panel permits operator control of voice (para. 160) and teletypewriter (para. 161) transmission over the radio communication system and wire-line facilities.

b. The control panel contains voice and teletypewriter circuits that consist of line amplifiers (transmit and receive), ringing and test-tone circuits, and a tty priority detector circuit. The control panel also contains a power supply and a monitor amplifier.

160. Voice Functions
(fig. 179)

a. Voice Lines. The control panel provides the following voice lines:

(1) Discrete line, two-wire, 600-ohm balanced, 20-cps ring.

(2) Command radio, four–wire, 600-ohm balanced, 1,600-cps ring.

(3) Army two-wire or four-wire line, 600-ohm balanced, 20-cps ring.

(4) Intrecom two-wire line, 600-ohm balanced, no ring.

(5) Vehicle radio, four-wire, radio keying control line, 150-ohm transmit (unbalanced), 600-ohm receive (unbalanced), no ring.

(6) Spare two-wire line, 600-ohm balanced, 20-cps ring.

(7) Radio terminal operator, four-wire headset. Provision is made for connecting the operator line singly to any one of the following: discrete, command, army, intercom, vehicle, or spare. By alternate selection (DISCRETE LINE SEL), it is possible to connect the discrete line to either command or army, and allow simultaneous connection of the operator to any of the four remaining lines. Both audible (20-cps) and visual (5-cps) ring indications are provided for the discrete, command, army, and spare lines. The ring indications are continuous and cease only when the operator connects himself by pressing the corresponding switch. Those lines which may only be switched *through* (in and out) the console provide ring indications only for the initial duration of the incoming ring (RING button down). Outgoing ring signals to the discrete, army, and spare lines (20 cps) and to the radio system (1,600 cps) are supplied by first connecting the desired line to the local operator and then pressing the RING pushbutton. Refer to the operator's manual, TM 11–5820–469–10, for the purpose and use of all pushbutton control switches.

b. Voice Circuits, Simplified Operation (fig. 12). This subparagraph outlines the functional operation of the control panel voice circuits. Refer to the simplified control panel diagram

(fig. 12) and to the functional schematic diagram of the control panel (fig. 179).

(1) The SPARE, VEHICLE, INTERCOM, ARMY, and COMMAND switches are interconnected so that, in normal operation, only one of these five controls is operated at a time. Pressing any one automatically releases the function previously used. Operation of the DISCRETE control (bright green illumination) releases any of the five controls and prevents their use.

(2) Operation of the discrete line selector COMMAND/ARMY switch does not, in itself, complete a functional circuit. It is necessary also to operate the COMMAND, ARMY or DISCRETE control.

(3) The voice circuits are so arranged that when the programmer test station (pts) is communicating with the distant radio set, the local operator can communicate with the Army area net or vehicle radio. When pts is communicating with the Army area net, the local operator can communicate with the distant radio set or vehicle radio. The intercom circuit between pts and local operator is available at all times except when the local operator is communicating with pts through normal communication channels.

(4) Facilities are provided for the operator to monitor the discrete (pts), intercom, vehicle, and spare voice circuits. Ring-in, ring-out, and ring-through facilities (from one party to the other) are also provided. The voice circuits are covered on a functional level in paragraphs 162 through 172.

c. Test Signal Function. Operation of the TEST SIGNAL switch does the following:

(1) Provides a local loudspeaker sidetone.

(2) Applies a 1,600-cps test tone to the radio transmit system (multiplexer) which can be adjusted by the operator to 0 dbm by use of the TEST SIGNAL LEVEL control on the front panel.

(3) Disables the 1,600-cps ring detector.

Note. When transmitting test tones for *signal location* or system level alignment, it is necessary for each terminal to operate in this manner. Otherwise, the test tone from one station will operate the ring detector at the other terminal.

d. Test Signal Indicator. The TEST SIGNAL indicator lights are interlocked with the DISCRETE LINE SEL switch so that illumination is amber when the COMMAND position is selected, but is green when the ARMY alternate is selected (command line available to the local operator). In the latter case, it is then only necessary to press the COMMAND switch (green) to complete the circuit to the local operator. This condition permits the DISCRETE switch (amber) to switch simultaneously to the Army line by also pressing the ARMY switch (amber). Refer to the functional block diagrams in figures 12 and 179 to understand the relationship of the various controls for voice communication and to paragraphs 162 through 172 for circuit analysis of the voice circuits.

161. Teletypewriter Circuits

The control panel permits the radio set operator to establish teletypewriter circuits between the local operator and Army, pts and Army, pts and distant radio operator, and radio operator to distant radio operator. A party loop between the local radio operator, pts, and Army can be established. The simplified functional block diagrams (figs. 13 through 17), the complete functional diagram (fig. 180), and paragraphs 173 through 176 cover the tie-in of the tty circuits, the teletypewriter switch panel, telegraph terminal, multiplexer, and the switch panel.

a. Teletypewriter Four-Wire Circuits.

(1) The four-wire local voice-frequency (vf) teletypewriter system consisting of the TT–335/TG and the TH–5A/

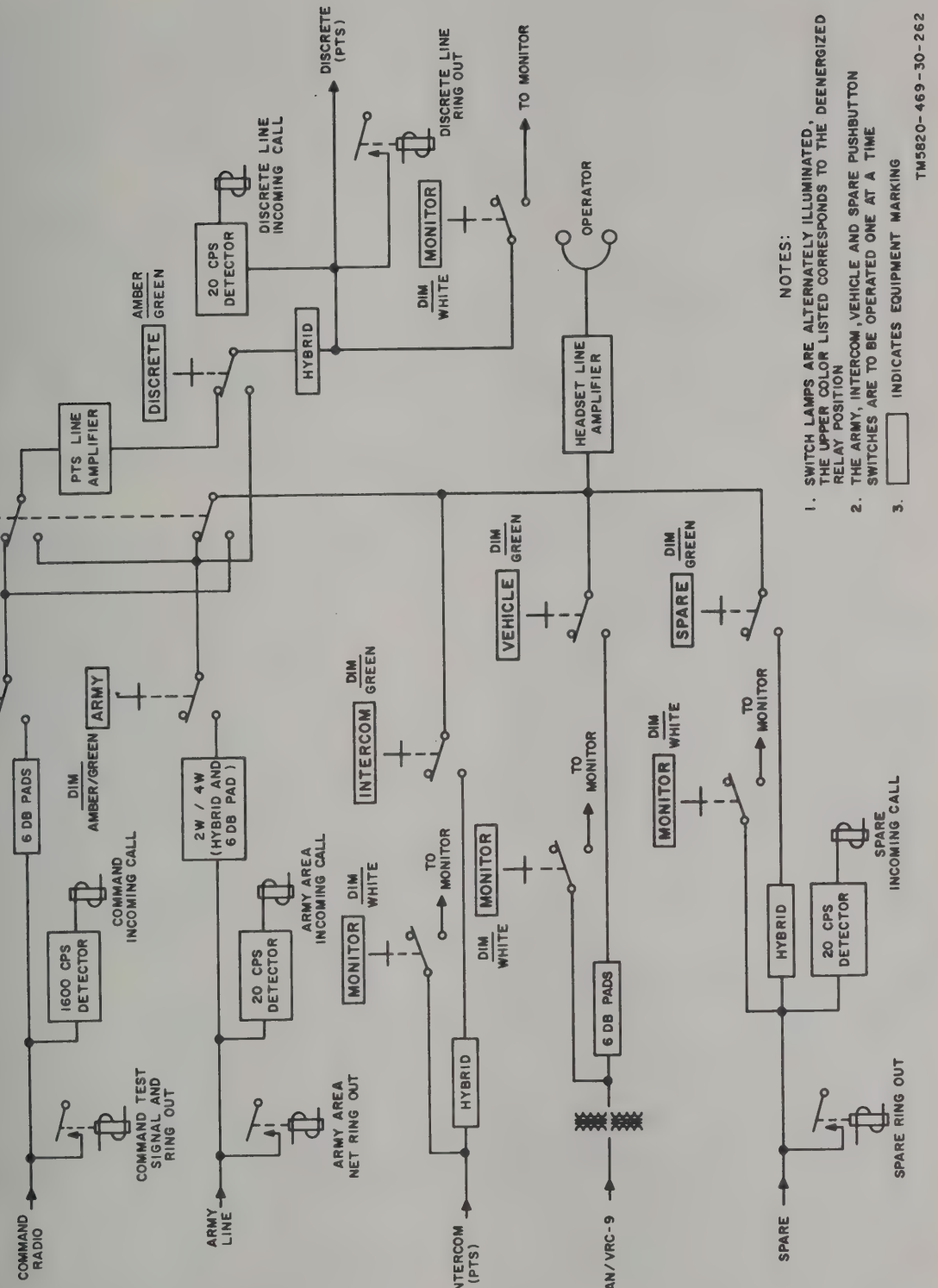


Figure 12. Control panel, simplified block diagram.

TG may be connected to the radio system (AN/TRC–80 to AN/TRC–80) or to the Army area net.

(2) The teletypewriter four-wire dc lines are normally connected to the dc send and receive jacks on the TH–5A/TG. The receive line may be opened (PTS-BY PASS switch at OFF) and the two-wire, 20-milliampere (ma) dc line extended to the programmer test station (pts).

(3) The teletypewriter keyboard and receive-coil connections can be switched to form a series dc loop with the Army and pts terminals on the power and signal entry panel. In this configuration, loop current must be supplied externally and the receive-coil connections would normally be switched in parallel for 60-ma operation.

(4) A relay-connected resistive bridge in the control panel couples a portion of the voice-frequency transmit signal from the TH–5A/TG back into the voice-frequency receive terminals to permit local self-copy on the operator's teletypewriter. This loop is interrupted when an incoming teletypewriter signal operates teletypewriter priority relay K23 (fig. 13), and permits only command messages to be printed.

b. Voice-Frequency Tty Circuit Switching (fig. 13).

(1) The alternate selection VF TTY switch transfers the input and output teletypewriter converter voice-frequency lines from the four-wire command radio to the four-wire Army area net. In the COMMAND position, the send (E3, E4) and receive (E5, E6) lines from the TH–5A/TG are ultimately connected through the control panel to the input (J9A and J9B) and output (J9D and J9E) of the multiplexer, when the selector switch in the teletypewriter switch panel has been set to NORMAL DC LOOP. Refer to the simplified schematic diagram (fig. 13).

(2) In the ARMY position of the VF TTY switch, these leads (E3, E4 and E5, E6) are externally available at J25, J23 and J26, J24 on the power and signal entry panel, regardless of the switch positions on the teletypewriter switch panel.

(3) The TH–5A/TG switches must be placed in the 4W and NORM positions for normal operation. The hybrid within the TH–5A/TG itself is not used. Instead, the hybrid within the teletypewriter switch panel is connected (VF 24/4W) when two-wire operation is desired.

c. Local Self-Copy Tty Priority Control (fig. 13).

(1) Local tty self-copy is possible even while continuously monitoring the command radio circuit for incoming traffic. When there are no incoming teletypewriter signals, the tty priority amplifier does not responod and relay K23 is deenergized. A resistive network (R82, R83, and R84) is connected to the TH–5A/TG 4–W send terminals (E3, E4) where these tones are supplied at a 0-dbm level. The bridge attenuation is factory-adjusted to supply —25 dbm for local self-copy at the 4W receive terminals (E5, E6) through the deenergized contacts of relay K23.

(2) The TH–5A/TG has a normal input threshold sensitivity of —50 dbm. However, a factory modification reduces this sensitivity to —35 dbm for use in the AN/TRC–80 system to minimize response to noise impulses. (A special power transformer is also used to permit operation from both 60- and 400-cps power.)

(3) The tty priority amplifier is adjusted to operate relay K23 when an incoming signal of —20 dbm or greater is available at TH–5A/TG terminals E5

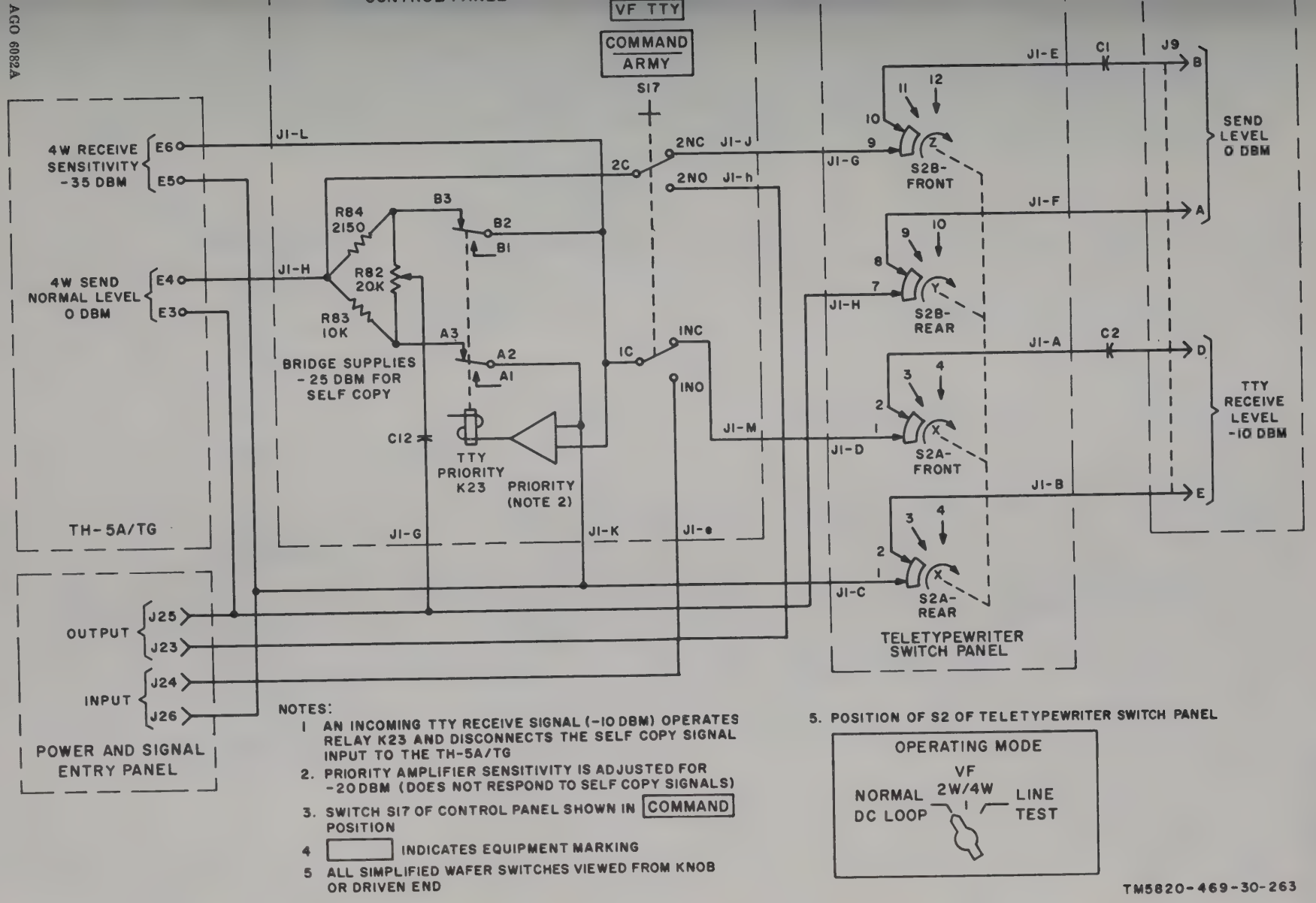
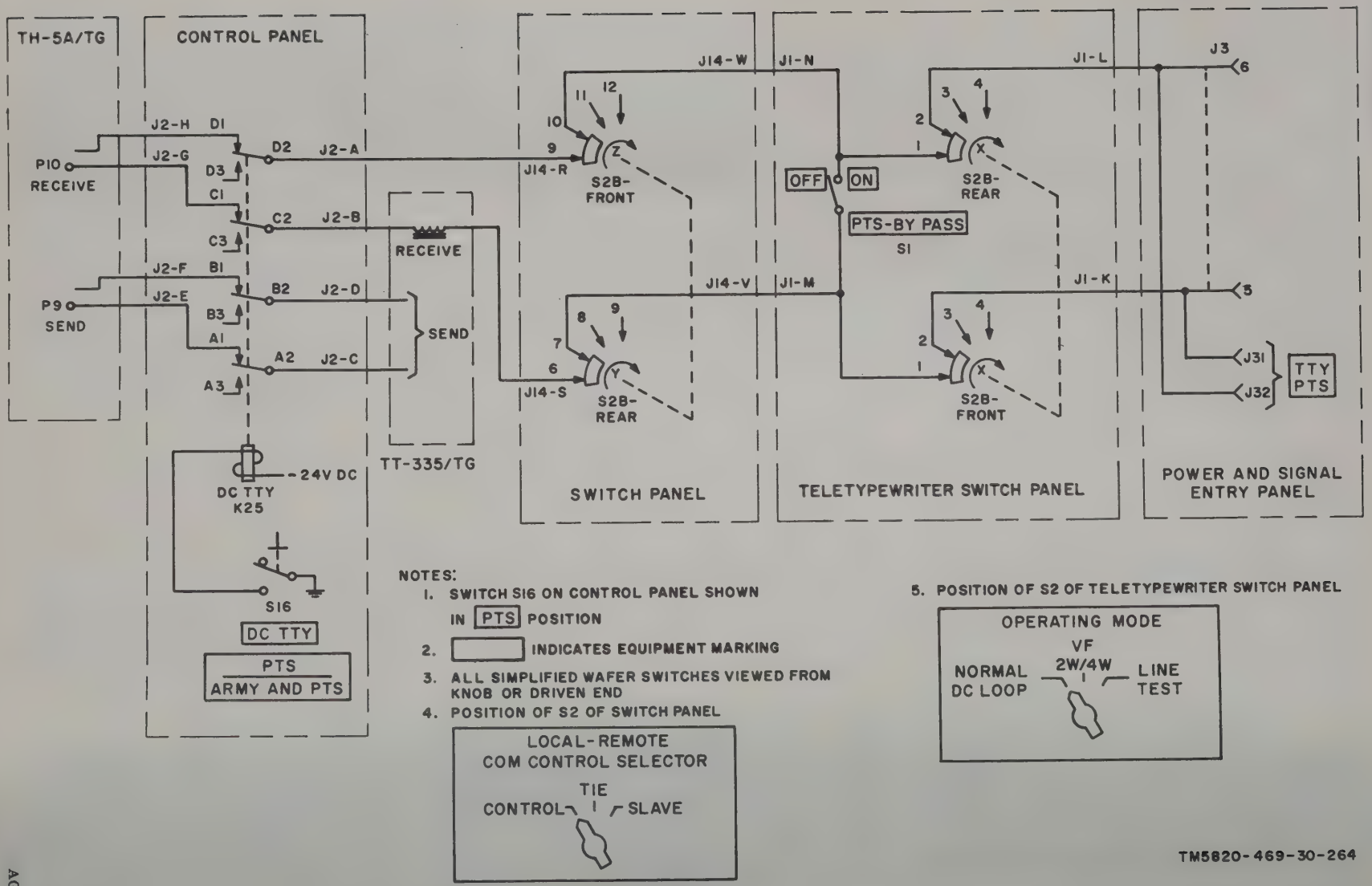


Figure 13. Tty signal routing through VF TTY switch S17, simplified schematic diagram.



NOTES:

1. SWITCH S16 ON CONTROL PANEL SHOWN IN [PTS] POSITION
2. [ ] INDICATES EQUIPMENT MARKING
3. ALL SIMPLIFIED WAFER SWITCHES VIEWED FROM KNOB OR DRIVEN END
4. POSITION OF S2 OF SWITCH PANEL

5. POSITION OF S2 OF TELETYPEWRITER SWITCH PANEL

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Figure 11. DC TTY with S16 in PTS position, simplified schematic diagram.

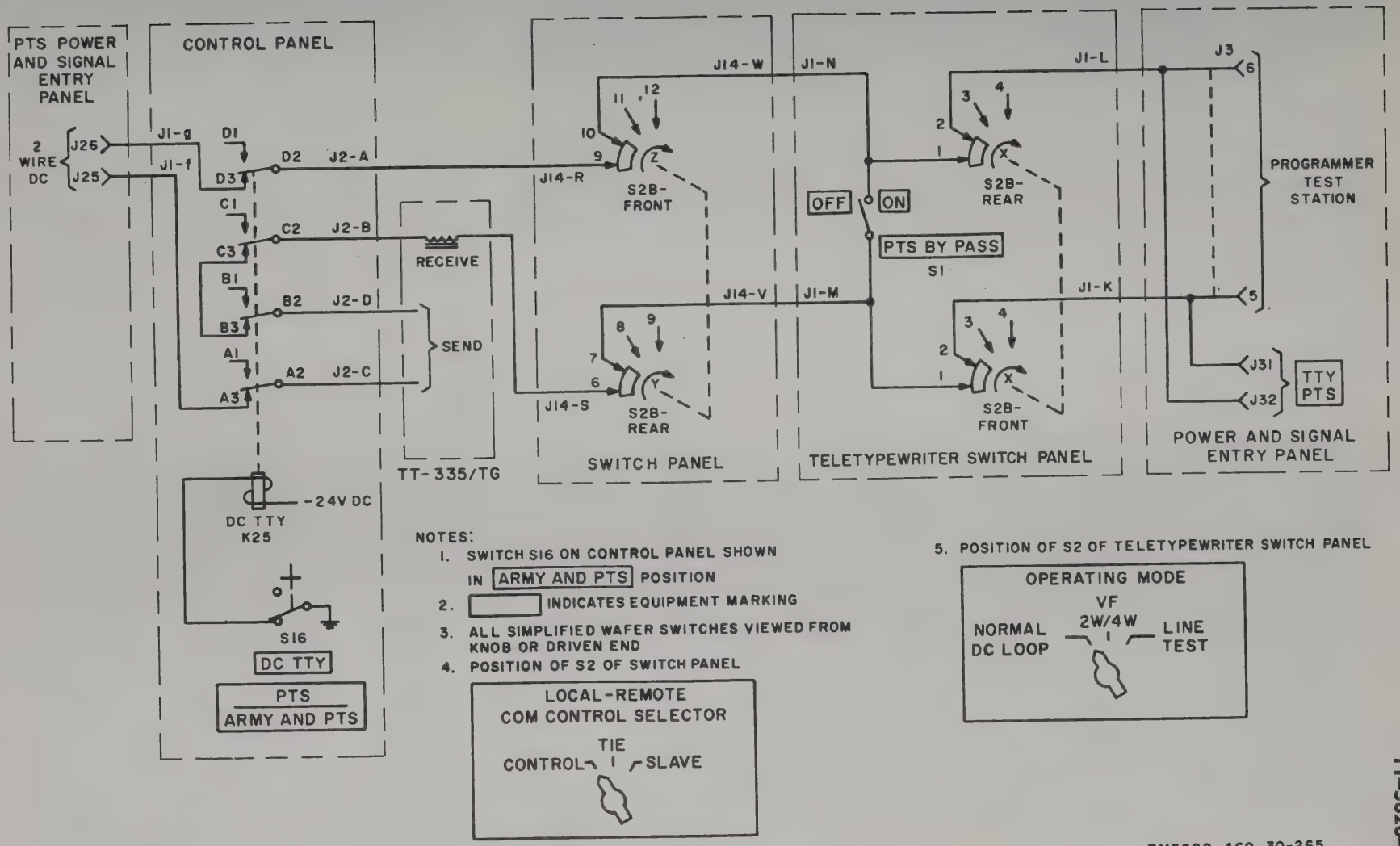


Figure 15. DC TTY switch S16 in ARMY AND PTS position, simplified schematic diagram.

and E6. The self-copy signal from the bridge network does not activate these circuits because its output si 5 db below the operating threshold of the priority amplifier. Normal incoming command radio teletypewriter signals come in at —10 dbm and operate relay K23. This removes the self-copy signals and permits only the command radio teletypewriter signals to operate the page printer. Series capacitors C1 and C2, located in the terminal board at the top of rack A1, prevent the line transformers in the multiplexer from short-circuiting the DC TTY (PTS) line.

d. DC TTY Circuit Switching (fig. 14).

(1) The normal position for alternate selection DC TTY switch S16 is the PTS or deenergized position (fig. 14). Note the circuit location of the PTS-BY PASS switch on the teletypewriter switch panel. This switch must be set to ON if local self-copy is desired. With the PTS-BY PASS switch set to OFF, a remote teletypewriter receive coil (or a short circuit) must be connected to TTY PTS terminals J3–5 and J3–6 or J31 and J32 on the power and signal entry panel. This permits both machines to print command radio messages and also permits one-way transmission from the loc keyboard to both the local and the r mote page printers. Further, if bot the keyboard and receive coil of th remote machine are series-connecte before connection to the power an signal entry panel, it is also possibl to send from the remote keyboard t both the local and remote page prin ers (as well as receive command radi messages). In these examples, the 2(ma direct current from the TH–5A TG is used as local battery.

(2) In the ARMY AND PTS position (fig 15) of DC TTY selector switch S1(the keyboard and receive coil ar placed in series with both the PT (J31 and J32) and the ARMY (J2 and J26) terminals on the power an signal entry panel. The TH–5A/T(is not connected. Normally, the 60 ma (parallel coils) position of the tt receive-coil selector switch will b used. Remote batery must be provide at one or more locations external t the AN/TRC–80 radio terminal. I this function is used, refer to figur 15 showing the actual routing of thes lines. The PTS-BY PASS switch mus be at ON unless a three-way part loop between AN/TRC–80, ARMY and PTS is desired.

Section II. VOICE CIRCUITS

162. Programmer Test Station and Local Operator (fig. 179)

Voice circuits between pts and the local operator are established by DISCRETE pushbutton switch S7. DISCRETE switch S7 energizes relay K9 and releases any previously engaged pushbuttons. DISCRETE pushbutton switch S7 is backlighted green when the local operator is connected to pts.

a. Transmit Path. Voice signals from the local microphone headset (connected to the control panel) are inductively coupled through transformer T4 to the transmit line amplifier. The amplified output of the transmit line am plifier is coupled through contacts of deener gized relay K8 and contacts of energized relay K9 to the hybrid network. The hybrid networks permit transmission and reception of voice sig nals over a two-wire line. Voice signals from the hybrid network are coupled through con tacts of deenergized ring-out relay K19 to pins A and B of jack 1. From jack J1, the voice signals are routed to pts.

Note. When voice lines are routed externally through a field switchboard such as the SB–22, a situation is created where these lines are open-ended (unterminated) unless the switchboard operator has plugged in a circuit. This action unbalances the hybrid circuits in the control panel and may lead to oscillation. Addition

a series 1 μf capacitor together with a 384 ohm sistor directly across the line at the signal entry nel terminates the line for the oscillation frequency, ereby preventing feedback. This action creates a par- l mismatch at other frequencies which is less trouble- ne.

b. Receive Path. Voice signals from pts are plied to the control panel through pins A d B of jack J1. From jack J1, the signals are upled through contacts of deenergized ring- t relay K19 to the hybrid network. The brid network routes the signals over the ansmit line through contacts of energized lay K9 and contacts of deenergized relay K8 the receive line amplifier. The amplifier out- t of the receive line amplifier is coupled rough HEADSET VOLUME control R95 to e headset receiver.

3. Programmer Test Station and Distant Radio Operator
(fig. 179)

To establish voice communication between s and the distant radio, the local operator de- esses DISCRETE LINE SEL pushbutton vitch S3, illuminating the COMMAND por- n of the pushbutton, and depresses COM- AND pushbutton switch S8. COMMAND shbutton S8 is backlighted bright amber nen the discrete line is connected to the com- and radio. When pushbutton switch S8 is osed, relay K15 energizes and relay K9 de- ergizes.

a. Transmit Path. Voice signals originating pts are applied to the control panel through ns A and B of jack J1. From jack J1, the ice signals are coupled through contact of energized ring-out relay K19 to the hybrid twork. The output from the hybrid network coupled through contacts of deenergized re- y K9 to the receive line amplifier. The receive e amplifier amplifies the voice signals to the oper level for application to the radio equip- ent. The output of the receive line amplifier coupled through contacts of deenergized relay 16, contacts of energized relay K15, a 6-db d, and contacts of deenergized relay K20 to ns N and P of jack J1. From jack J1, the ice signals are applied to the transmit equip- ent of the radio set.

b. Receive Path. Voice signals from the receive equipment of the radio set are applied to pins R and S of jack J1. From jack J1, the voice signals are coupled through contacts of deenergized relay K20, a 6-db pad, contacts of energized relay K15, and contacts of deenergized relay K16 to the transmit line amplifier. The voice signals are amplified to the proper level for transmission to pts. The amplified output of the transmit line amplifier is coupled through contacts of deenergized relay K9 to the hybrid network. The output of the hybrid network is coupled through contacts of deenergized ring-out relay K19 to pins A and B of jack J1.

164. Programmer Test Station and Army Area Net
(fig. 179)

To establish voice communication between pts and Army area net, the local operator sets DISCRETE LIN SEL pushbutton switch S3 to ARMY and depresses ARMY pushbutton switch S9. Relays K8 and K16 are energized by closing switch S9. After this circuit has been established, the local operator can communicate with the distant radio set (para. 166).

a. Transmit Path. Incoming voice signals from pts are applied to the control panel through pins A and B of jack J1 and coupled through contacts of deenergized relay K19 to the hybrid network. The output of the hybrid network is coupled through contacts of deenergized relay K9 to the receive line amplifier. The output of the receive line amplifier is coupled through contacts of energized relay K16 to the contacts of relay K7. The voice signals are coupled through contacts of energized relay K7 to the contacts of relay K1. Relay K1 permits the Army area net to operate with a two-wire or four-wire line. When relay K1 is deenergized (four-wire operation), the transmit voice signals are coupled through contacts of deenergized relay K1, a 6-db pad, another set of contacts of deenergized relay K1, and contacts of deenergized relay K21 to the two-wire transmit line (pins V and W of jack J1). When relay K1 is energized (two-wire operation),

the transmit voice signals are coupled through contacts of energized relay K1 to a hybrid network. The output of the hybrid network is coupled through contacts of energized relay K1 and contacts of deenergized relay K27 to the two-wire receive line (pins T and U of jack J1). In two-wire operation, the two-wire receive line is used for transmit and receive.

b. Receive Path. The Army area net incoming signals are applied to the control panel through pins T and U of jack J1. From jack J1, the voice signals are coupled thorugh contacts of deenergized relay K27 to contacts of relay K1. When relay K1 is deenergized (four-wire operation), the receive signals are coupled through contacts of deenergized relay K1, a 6-db pad, and another set of contacts of deenergized relay K1 to the contacts of relay K7. When relay K1 is deenergized (two-wire operation), the receive signals are coupled through contacts of energized relay K1 to a hybrid network. The output of the hybrid network is coupled through another set of contacts of K1 to the contacts of relay K7. The signals are coupled through the contacts of energized relay K7 and contacts of energized relay K16 to the transmit line amplifier. The output of the transmit line amplifier is coupled through contacts of deenergized relay K9, the hybrid network, and contacts of deenergized relay K19 to pins A and B of jack J1.

165. Local Operator and Army Area Net (fig. 179)

With voice communication established between pts and the distant radio (para. 163), the local operator may establish voice communication with the Army area net by depressing ARMY pushbutton switch S9. (The COMMAND portion of the DISCRETE LINE SEL switch is already depressed.) The ARMY pushbutton is backlighted bright green when the Army net is connected to the local operator's circuit. ARMY TELEPHONE pushbutton switch S15 is normally preset to 2 WIRE or 4 WIRE, depending on the line connections to the power and signal entry panel.

a. Transmit Path. Voice signals from the local headset transmitter are inductively coupled through transformer T4 to the transm line amplifier. The amplified output of t transmit line amplifier is coupled through co tacts of deenergized relay K8 to the energiz contacts of relay K7. The signal path fro relay K7 is identical with the pts and Arn area net voice circuit (para. 164*a*).

b. Receive Path. The Army area net incor ing signal path to relay K7 is identical wi the pts and Army area net vioce circuit (par 164*b*). The receive signals are coupled throu contacts of energized relay K7 and contacts deenergized relay K8 to the receive line ampl fier. The amplified output of the receive li amplifier is coupled thorugh HEADSET VO UME control R95 to the local headset receive

166. Local Operator and Distant Radio Set (fig. 179)

When pts is connected to the Army area ne the local operator may communicate with th distant radio set by depressing COMMAN pushbutton switch S8. (This action connec the control panel audio circuits to the comman radio.) The transmit and receive signal path are identical with the programmer test statio and distant radio operator (para. 163) excep the voice signals are to and from the local hea set, and are connected to the command radi line through contacts of energized relay K8.

167. Local Operator and Vehicle Radio (fig. 179)

Voice communication between the local ope ator and vehicle radio (AN/VRC–9) is estab lished by depressing VEHICLE pushbutto switch S11. The closing of switch S11 energize relay K3. The VEHICLE pushbutton is back lighted bright green when the vehicle radio an local operation circuits are connected. Th vehicle radio is keyed by the local operator' press-to-talk pushbutton.

a. Transmit Path. Voice signals from th local headset transmitter are inductivel coupled by transformer T4 to the transmit lin amplifier. The amplified output of the transmi line amplifier is coupled through contacts c energized relay K3 and a 6-db pad to trans

rmer T2. The transmit signal is inductively upled by transformer T2 to pins X and Y of ck J1.

b. Receive Path. Incoming voice signals om the vehicle radio are applied to the con- ol panel through pins Y and Z of jack J1 and ductively coupled by transformer T3 to a -db pad. The received signals from the 6-db ad are coupled through contacts of energized lay K3 to the receive line amplifier. The mplified output of the receive line amplifier is upled through HEADSET VOLUME control 95 to the local headset receiver.

68. Local Operator and Intercom (fig. 179)

Voice communication between the local oper- tor and the programmer test station is estab- shed by use of the intercom circuit. This rcuit does not interrupt voice communication etween pts and the command radio. To estab- sh the intercom circuit, the operator depresses NTERCOM pushbutton switch S10, thereby nergizing relay K17. The INTERCOM push- utton is backlighted bright green when the ts intercom and local operator circuit is estab- shed. Voice signals from the local headset ransmitter are coupled through the transmit ne amplifier and contacts of energized relay 17 to a hybrid network. The output of the ybrid network is applied to pins C and D of ck J1. Incoming voice signals are applied to ne control panel through pins C and D of jack 1 and coupled through the hybrid network, ntacts of energized relay K17, and the receive ne amplifier to the local headset receiver.

69. Local Operator and Spare (fig. 179)

Voice communication between the local oper- tor and spare circuit is established by depress- g SPARE pushbutton switch S12. This action nergizes relay K5. The SPARE pushbutton backlighted bright green in this condition. oice signals from the control panel headset icrophone are coupled through the transmit ne amplifier and contacts of energized relay 5 to a resistive hybrid network. The output the hybrid network is connected to pins E and F of jack J1. Incoming voice signals are connected to the control panel through pins E and F of jack J1 and are coupled through the hybrid network, contacts of energized relay K5, and the receive line amplifier to the headset receiver.

170. Monitor Circuits (fig. 179)

Monitor switches are provided to enable the operator to monitor incoming voice signals. MONITOR switch S4 connects the pts intercom voice signals to the monitor matrix. MONITOR switch S5 connects the vehicle radio incoming voice signals to the monitor matrix. MONITOR switch S6 connects the spare line voice signals to the monitor matrix. The monitor matrix provides the proper impedance matching to prevent loading of the circuit being monitored. The output of the monitor matrix is applied to the monitor amplifier. The voice signals are amplified and coupled to the speaker.

171. Local Ringing Circuits (fig. 179)

A 20-cps ringing voltage is used for ring-in and ring-out on the Army area net and pts discrete line. The command line uses a 1,600-cps signaling for ring-in and ring-out.

a. Pts Ring-In. A 20-cps ringing voltage from pts is applied to pins A and B of jack J1. The ringing voltage is coupled through contacts of deenergized relay K19 to the 20-cps detector. The 20-cps ringing voltage applied to the detector energizes incoming call relay K13. One set of contacts couples a 1,600-cps signaling tone to the monitor amplifier where it is amplified and coupled to the speaker to alert the operator. The other set of contacts, associated with the incoming call relay, couples a 5-cps flasher signal from the ring generator to the DISCRETE pushbutton and causes it to flash at a 5-cps rate. This indicates to the operator the origin of the incoming call.

b. Army Area Net, Spare Line, and Command Line Ring-In. A ring-in signal from the Army area net, the spare line, or the command line causes the same operation as described in

a above. Instead of the 20-cps ring voltage, the command line uses a 1,600-cps signaling tone.

c. Ring-Out Circuits. The operator can ring out to pts, Army area net, spare line, or the command line. To ring out, the switch associated with the called party (DISCRETE, COMMAND, or ARMY) must be depressed. Depressing RING switch S14 energizes the ring generator and the associated ring-out relay (K19 for pts, K20 for command, K21 for Army area net, and K22 for the spare line). A 20-cps ringing voltage is applied through contacts of relays K19, K22, and K21. A 1,600-cps signaling tone is applied through contacts of relay K20. When RING switch S14 is released, the associated ring-out relay is deenergized.

172. Ring-Through Circuits (fig. 181)

When the circuits between pts and Army area net, or pts and the distant radio set are established, ringing the called party can be done by the calling party. For example, when the circuit between pts and the distant radio set is established, pts can ring the distant radio station or the distant radio station can ring pts.

a. Pts to Distant Radio Station. A 20-cps ringing voltage from pts is applied to a 20-cps detector, which results in the energizing of relay K13. Power supply common is coupled through contacts D2 and D3 of relay K13, contacts B2 and B1 of relay K28, contacts F2 and F1 of relay K8, and contacts E2 and E3 of relay K15, to relay K20. Relay K20 energizes and applies a 1,600-cps signaling tone to the command radio transmit line. When the pts ring key is released, relay K13 deenergizes and removes power supply common from relay K20. When relay K20 deenergizes, the 1,600-cps signaling tone is removed from the command radio transmit line.

b. Distant Radio Station to Pts. A 1,600-cps signaling tone from the command radio receive line is applied to the 1,600-cps detector, which results in the energizing of relay K12. Power supply common is coupled through conta B3 and B2 of relay K12, contacts B3 and B2 relay K14, contacts A1 and A2 of relay K and contacts F1 and F2 of relay K9, to rel K19. Relay K19 energizes and applies a 20-c ringing voltage to the pts discrete line. Wh the command radio switch is released, rel K12 deenergizes and, in turn, removes pow supply common from relay K19. Relay K19 energizes, and the 20-cps ringing voltage removed from the pts discrete line.

c. Pts to Army Area Net. A 20-cps ringi voltage from pts is applied to a 20-cps detect which results in the energizing of relay K1 Power supply common is coupled through co tacts D2 and D3 rf relay K13, contacts B2 a B1 of relay K28, contacts F2 and F3 of rel K8, and contacts E2 and E3 of relay K7, Army ring-out relays K27 and K21. Relay K couples a 20-cps ringing voltage to the Arm area net two-wire transmit line. In two-wi operation, the 20-cps ringing voltage is coupl through contacts of relay K21 and switch S to the Army area net two-wire receive-transm line. Relay K27 prevents the 20-cps ringi voltage from being applied to the receive li of the pts discrete line. When the pts ring k releases, relay K13 deenergizes. When rel K13 deenergizes, power supply common is r moved from relays K21 and K27 and, in tur removes the 20-cps ringing voltage from t Army area net lines.

d. Army Area Net to Pts. A 20-cps ringi voltage from the Army area net is applied to 20-cps detector, which results in the energizi of relay K11. Power supply common is coupl through contacts B3 and B2 of relay K11, co tacts B3 and B2 of relay K6, contacts A3 a A2 of relay K8, and contacts F1 and F2 of rel K9, to ring-out relay K19. Relay K19 energiz and applies a 20-cps ringing voltage to the p discrete line. When the Army ring key is r leased, relay K11 deenergizes. This remov power supply common from ring-out relay K1 When relay K19 deenergizes, the 20-cps ringi voltage is removed from the pts discrete line.

Section III. TELETYPEWRITER CIRCUITS

3. Programmer Test Station Radio Teletypewriter Circuit (figs. 16 and 180)

a. To establish the radio teletypewriter cir-t between pts and the distant radio set, etypewriter switch panel OPERATING ODE switch S2 is set to VF 2W/4W. A sim-fied circuit of the connections that are made this position of switch S2 is illustrated in ure 16. Follow the simplified diagram and the nplete schematic diagram (fig. 180) in this cussion. Mark and space tty tones, 1,325 and 25 cps respectively, from pts are applied to radio terminal set power and signal entry nel jack J3 between pins 5 and 6. The tty es from jack J3 are applied to a hybrid net-rk in the teletypewriter switch panel ough TB3 rack A3, TB13 rack A2, and the 2W/4W position of OPERATING MODE itch S2. The tty tones are applied across hy-d network terminals L–P and inductively pled to hybrid network secondary windings W and G–E. The signal developed across secondary windings of the hybrid network applied between pins A and B of jack J9 of multiplexer through the VF 2W/4W posi-n of S2, TB13 rack A2, TB 3 rack A1, and nector P1.

b. The received tty signals from the distant dio set appear at the output of the multi-xer between pins D and E of jack J9. The put from the multiplexer is applied to wind-gs T and H of the teletypewriter switch panel brid network TB3 rack A1, TB13 rack A2, d the VF 2W/4W position of switch S2. The nal is inductively coupled to winding P and of the hybrid network and applied between s 5 and 6 of power and signal entry panel k J3 through the VF 2W/4W position of itch S2, TB13 rack A2, and TB3 rack A3. e output at J3 (located at the power and sig-entry panel) is applied to pts by cable.

4. Radio Set Teletypewriter Circuit (figs. 17 and 180)

A radio tty circuit between the local radio operating facilities and the distant radio set is established by depressing VF TTY push-button S17 to illuminate the COMMAND switch (upper portion), and setting OPERATING MODE switch S2 to NORMAL DC LOOP. Switch S17 (COMMAND) is located on the control panel and switch S2 is located on the teletypewriter switch panel. A simplified circuit of the connections that are made when S2 is set to the NORMAL DC LOOP position is provided in figure 17. Follow the simplified diagram and the complete schematic diagram (fig. 180) in this discussion.

a. Transmit Path. The dc mark and space current outputs (send) of the teletypewriter are applied to pins C and D of jack J2 of the control panel. The current pulses are coupled through the deenergized contacts of relay K25 to pins E and F of jack J2. From this point, the current pulses are applied to the telegraph terminal through SEND plug P9. Within the telegraph terminal, the dc pulses are converted to voice frequencies (1,325 cps for a mark and 1,225 cps for a space). The telegraph terminal mark and space tones are connected through wires E3 and E4 (fig. 17) and applied to terminals 17 and 18 of TB11 on panel A1 of rack A2. A portion of the signal is applied to the control panel self copy hybrid network through pins G, H, and J of jack J1. The hybrid is unbalanced slightly so that the transmitted signals are applied to the local teleprinter. From TB11, the mark and space tones are applied to pins G and H of teletypewriter switch panel jack J1. The signals are routed through the NORMAL DC LOOP position of switch S2 and pins E and F of jack J1 to TB13 on panel A1 of rack A2. From TB13, the signals are routed through TB3 rack A1 to pins A and B of multiplexer send jack J9. The mark and space radio tty signals are then transmitted to the distant radio set.

b. Receive Path. The received radio tty signals from the distant radio set are taken at the output of the multiplexer between pins D and E of jack J9. The signals are applied to TB13 on panel A1 of rack A2 through TB3 of rack A1. The received signals at TB13 are connected

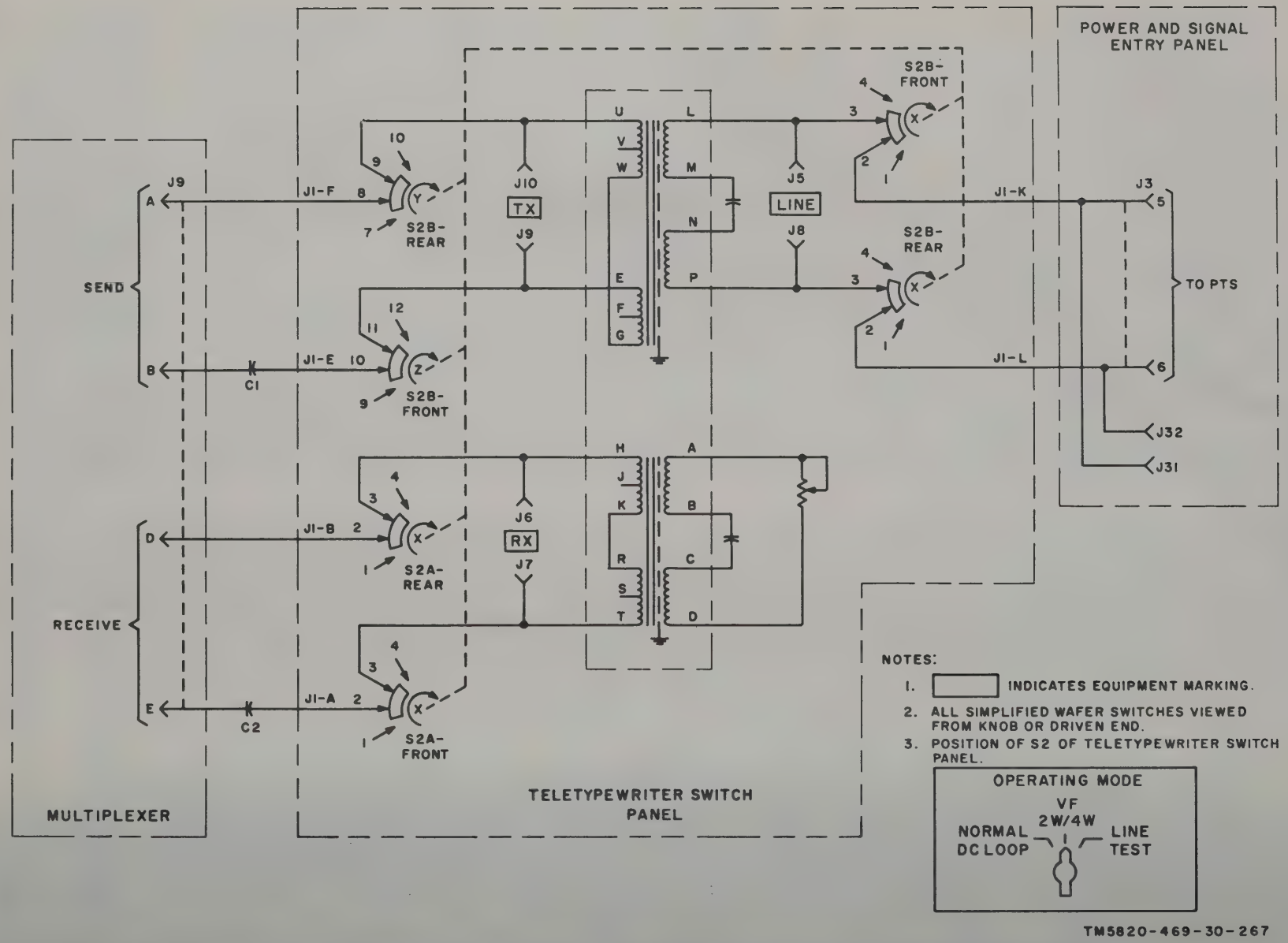
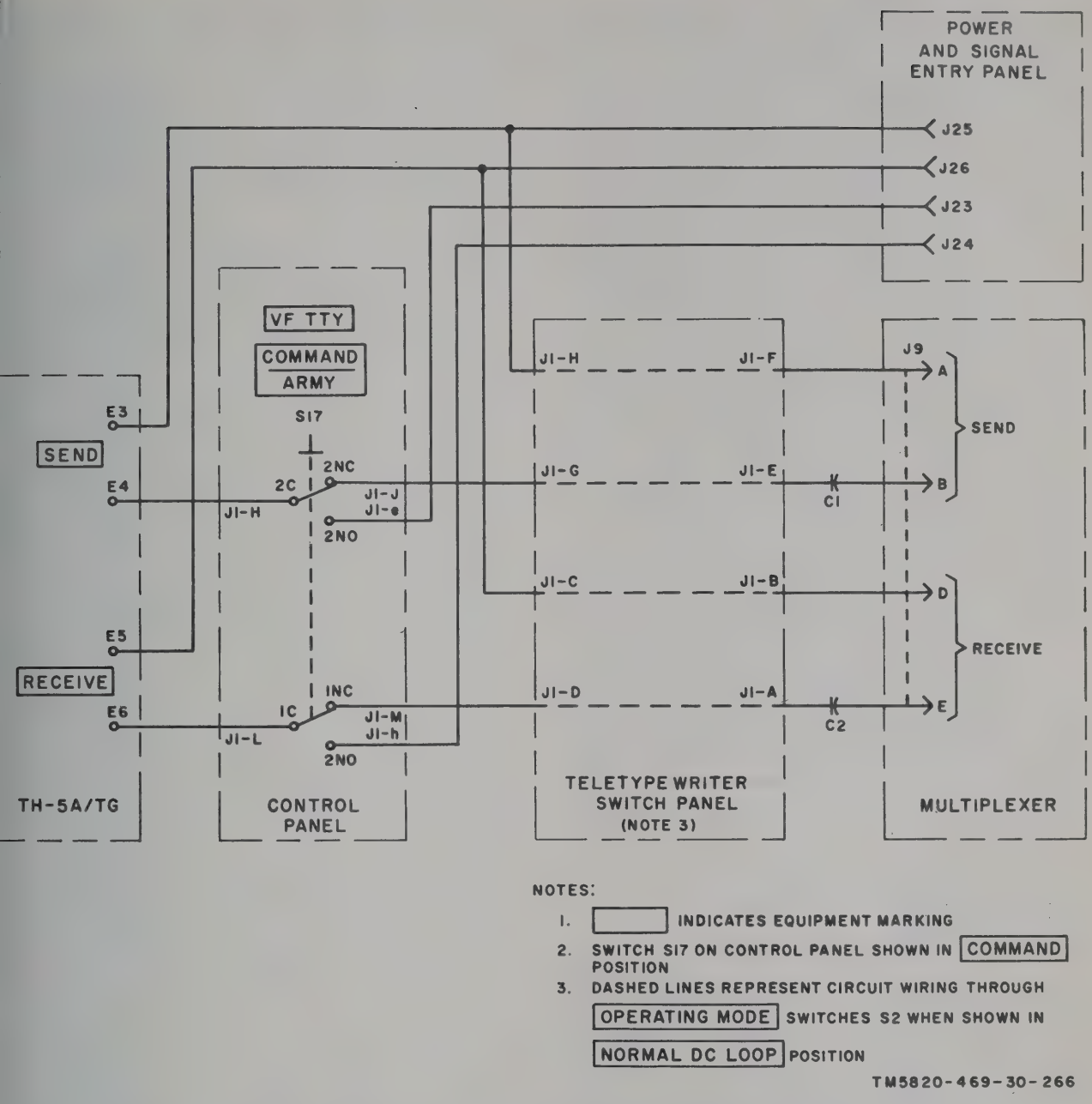


Figure 16. Teletypewriter switch panel connections with OPERATING MODE switch in the VF 2W/4W position, simplified schematic diagram.



NOTES:

1. [ ] INDICATES EQUIPMENT MARKING
2. SWITCH S17 ON CONTROL PANEL SHOWN IN [COMMAND] POSITION
3. DASHED LINES REPRESENT CIRCUIT WIRING THROUGH [OPERATING MODE] SWITCHES S2 WHEN SHOWN IN [NORMAL DC LOOP] POSITION

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Figure 17. Teletypewriter switch panel, circuit connections, OPERATING MODE switch S2 in NORMAL DC LOOP, simplified schematic diagram.

o the teletypewriter switch panel through pins A and B of jack J1, the NORMAL DC LOOP position of S2, and back to pins C and D of ack J1. The output from the teletypewriter witch panel (1,325- and 1,225-cps tones) is pplied to TB15 on panel A1 of rack A2. From his point, the signals are applied to two places: One output is routed to the tty priority detector through pins K, L, and M of control panel jack J1. Since the level of the received signals (from the multiplexer) is greater than the level of the local self copy signals, the detector circuit energizes relay K23, removes the locally transmitted signal from the teleprinter, and causes the incoming signal to be printed. The other output from TB15 is routed to the telegraph terminal through E5 and E6. Within the telegraph terminal, the voice-frequency radio

tty signals are converted to dc pulses. The dc output of the telegraph terminal is routed through receive plug P9, through pins G and H of control panel jack J2, through contacts of deenergized relay K25, and pins A and B of jack J2, to TB7 on panel A1 of rack A2. One side of the line from TB7 is applied to one receive terminal of the local teleprinter. The other side of the line is coupled through LOCAL-REMOTE COM CONTROL SELECTOR switch S2 of the switch panel to the teletypewriter switch panel. The signals are applied through pins R and S of switch panel jack J14, through switch S2, pins W and V of jack J14, through TB9 rack A2, to teletypewriter switch panel S2 and PTS-BY PASS switch S1. With switch S1 at ON, the pts teleprinter is out of the circuit. With switch S1 at OFF, the pts teleprinter is in a series loop with the local teleprinter. With switch S1 at OFF, the signal is routed to pin 6 of J3 through the NORMAL DC LOOP section of switch S2, TB-13 rack A2, and TB3 rack A3. The signal is routed through the PTS cable to the teleprinter and back to pin 5 of jack J3. From this point, the signal is routed through the teletypewriter switch panel, switch S2, and through switch panel switch S2B to the other receive terminal of the local teleprinter to complete the dc circuit.

175. Dc Teletypewriter Circuit (fig. 180)

a. A three-party two-wire dc tty loop is established between Army, pts, and operator by depressing DC TTY PTS/ARMY AND PTS switch S16 (illuminating ARMY AND PTS (lower) portion of the switch), setting OPERATING MODE switch S2 to NORMAL DC LOOP, and setting PTS-BY PASS switch S1 to OFF. Switch S16 is located on the control panel, and switches S1 and S2 are located on the teletypewriter switch panel. This action places the three teletypewriters in series, permitting any one of the teletypewriters to send or receive.

Note. Establishing the three-party two-wire dc tty loop disrupts the radio teletypewriter circuit operation (para. 174).

b. One side of the send line from the loca teletypewriter is routed through pin C of con trol panel jack J2, contacts of energized relay K25, to contact *f* of control panel J1. From jack J1, the line is routed through terminal 11 of TB11 on panel A1 of rack A2, to jack J22 of TB2 on rack A11 of the power and signal entry panel. At TB2, the line is returned from J24 through TB11 terminal 12 on panel A11 of rack A2, to pin G of jack J1 on the control panel. The line is then routed through contacts of energized relay K25 to pin A of control panel jack J2. From J2, the line is routed through terminal 15 of TB7 on panel A1 of rack A2 to switch panel jack J14. From jack J14, the line is routed through pin R, switch S2, to pin W of jack J14. From pin W of jack J14, the line is routed through TB9 terminal 1 on panel A1 of rack A2, to pin N of teletypewriter switch panel jack J1, through switch S2 and pin L of jack J1, to TB13 terminal 17 on panel A1 of rack A2. From TB13, the line is routed through TB3 rack A3 to terminal 6 of power and signal entry panel jack J3. At this point, the pts teletypewriter is series-connected with the local and Army teletypewriters. The pts teletypewriter return line is routed through terminal 5 of jack J3, TB3 terminal 8 rack A3, to TB13 terminal 16 on panel A1 of rack A2. From TB-13, the line is routed to pin K of teletypewriter switch panel jack J1, through switch S2, to pin M of jack J1. From jack J1, the line is routed through TB9 on panel A1 of rack A2, to pin V of switch panel jack J14. From jack J14, the line is routed through switch S2 to pin S of jack J14 to TB7 terminal 16 on panel A1 of rack A2, and back to the local teletypewriter. The dc loop is completed through the other side of the receive circuit to TB7 terminal 14 on panel A1 of rack A2, to pin B of control panel jack J2, through contacts of energized relay K25, to pin D of jack J2, and back to the send side of the teletypewriter.

176. Army Four-Wire Vf Tty Circuit (fig. 180)

A four-wire VF tty circuit between the operator and Army can be established by depressing VF TTY COMMAND/ARMY switch S17 (illuminating the ARMY (lower) portion of

he switch) and setting OPERATING MODE witch S2 to NORMAL DC LOOP. Switch S17 s located on the control panel, and switch S2 s located on the teletypewriter switch panel. The pts teletypewriter is connected into the oop only when PTS-BY PASS switch S1, ocated on the teletypewriter switch panel, is t OFF.

a. Transmit Path. Dc pulses from the local eletypewriter are coupled through the control anel (contacts of deenergized relay K25) to he telegraph terminal. The dc pulses are con-erted to mark and space tones by the tele-raph terminal. One side of the dc loop (from vire E3 of the telegraph terminal) is applied o jack J21 of TB2 on the power and signal en-ry panel, through TB11 on panel A1 of rack A2 (terminals 18 and 11). The other side of he loop (from wire E4 of the telegraph term-nal) is applied to J22 of TB2 on the power and ignal entry panel, through pin *f* of jack J1 on he control panel (switch S17 in the ARMY osition), and TB11. The output from TB2 con-ects to the Army area net tty circuit.

b. Receive Path. Mark and space tones from Army are applied to the radio set. The tones are onverted to dc pulses by the telegraph term-nal. The dc pulses are in turn applied to the ocal teleprinter. With PTS-BY PASS switch 1, located on the teletypewriter switch panel, et to OFF, pts monitors Army transmissions. With the switch at ON, pts is out of the circuit.

(1) One side of the loop from Army is applied to power and signal entry panel jack J23 of TB2. The mark and space tones from J23 are applied to wire E5 of the telegraph terminal through TB11 and TB15 on panel A1 of rack A2. The dc output at RECEIVE plug P10 (A) of the telegraph terminal is applied to the receive terminals of the local teleprinter through the control panel (contacts of deenergized relay K25) and TB7.

(2) The other side of the loop from Army is applied to power and signal entry panel jack J24 of TB2. The mark and space tones from J24 are applied to wire E6 of the telegraph terminal through TB11, control panel switch S17 (in the ARMY position), and TB15. The dc pulses from RECEIVE plug P10 (B) of the telegraph terminal is applied to pin 6 of power and signal entry panel jack J3 (PROGRAMMER TEST STATION) through deenergized control panel relay K25, TB7, switch panel (through pins R and W of jack J14), TB9, teletypewriter switch panel (through pins N and L of jack J1), and TB13 and TB3. From jack J3, pulses are applied to the pts tty by cable. The return from pts is applied to pin 5 of power and signal entry panel jack J3. From J3, the dc pulses are applied to the local teleprinter through TB3 and TB-13, teletypewriter switch panel, TB9, switch panel, and TB7.

Section IV. CIRCUIT FUNCTION

77. General

The control panel is composed of a main hassis containing a power supply section, ring enerator, control and protective circuits, and even plug-in circuit boards. Paragraphs 178 hrough 185 cover the circuit function of the ircuit boards, the ring generator, and power upply circuits.

78. Receive and Transmit Line Amplifier (fig. 18)

a. General. Two receive and transmit line mplifier circuit boards are used. One circuit board is used with the pts discrete line and the other is used with the local operator's headset. The two amplifier circuit boards are identical. The transmit line amplifier used with the pts discrete line accepts voice signals from the command radio line or Army area net and amplifies the signals before they are applied to the discrete line. The receive line amplifier used with the discrete line accepts voice signals from the discrete line and amplifies the signals before they are applied to the command radio line or Army area net. The transmit line amplifier used with the local operator's headset provides

amplification of voice signals from the local headset transmitter. The receive line amplifier used with the local operator's headset accepts the received signals and amplifies the signals before they are applied to the local headset receiver.

b. Transmit Section.

(1) *Input circuit.* Voice signals are applied between pins A and C and inductively coupled to the secondary of transformer T1. The input signal is developed across the secondary of T1 and gain adjust control R12 and applied to the base of transistor Q1.

(2) *Amplifier Q1.* Transistor Q1 provides amplification of the input signal. Base bias voltage for Q1 is furnished by voltage divider R1 and R2. Bias stabilization is furnished by resistor R5, which is bypassed by capacitor C1. Resistor R4 provides a small amount of degeneration for gain stabilization. The amplified signal developed across collector load resistor R3 is applied to the base of transistor Q2 through capacitor C3.

(3) *Amplifier Q2.* The amplifier output of Q1 is further amplified by transistor Q2. Base bias voltage for Q2 is furnished by voltage divider R6 and R7. Bias stabilization is furnished by resistor R10, which is bypassed by capacitor C2. A small amount of degeneration is provided by unbypassed resistor R9 for gain stabilization. The amplified output developed across load resistor R8 is applied to output transformer T2 through capacitor C4. The voice signal is inductively coupled to the secondary of T2. The signal developed across the emitter circuit of Q2 is applied through potentiometer R11 and capacitor C5 to the base of Q1 as feedback. This feedback stabilizes the overall gain of the circuit and improves the frequency response of the amplifier.

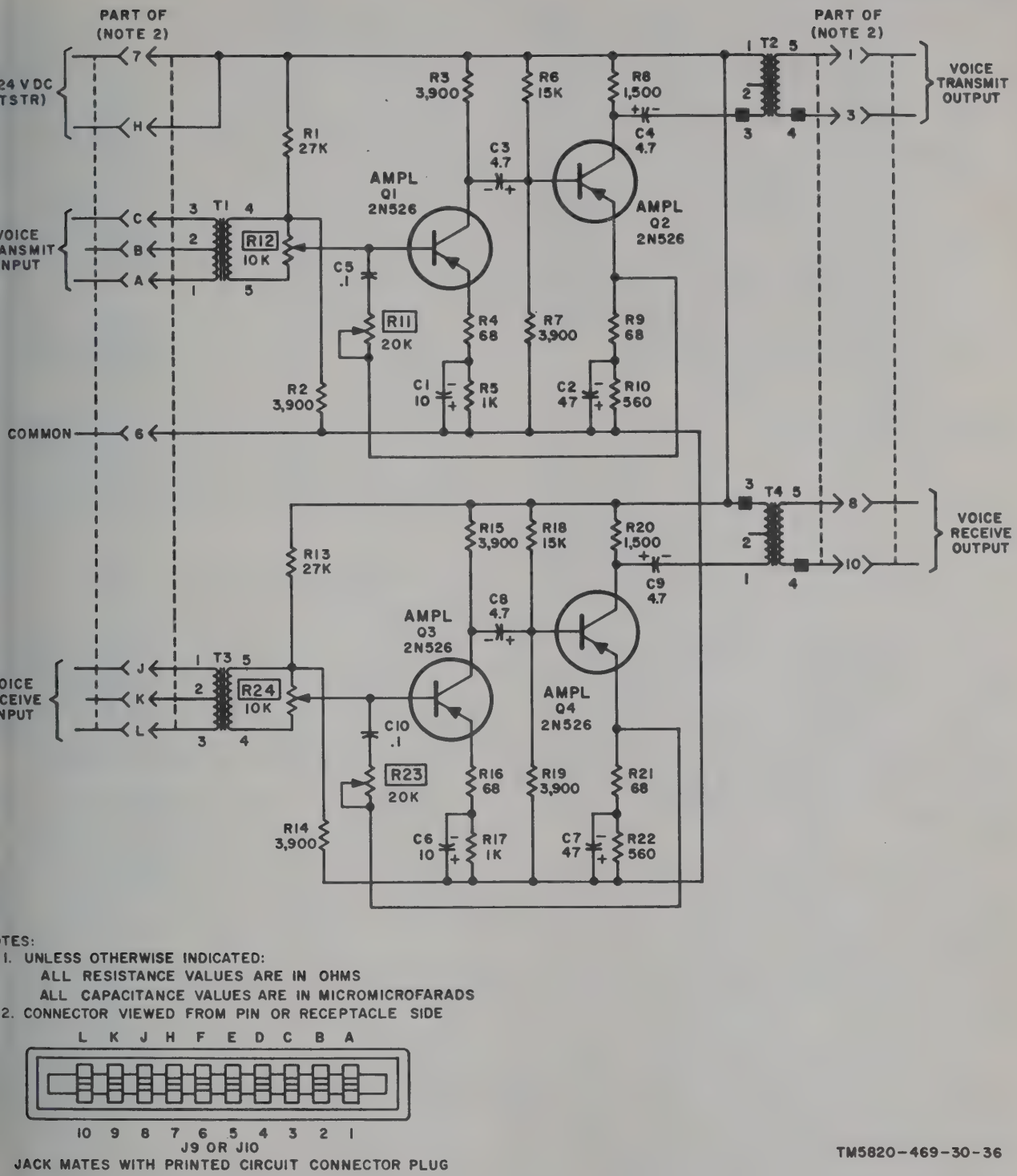
c. Receive Section. Voice signals are applied between pins J and L and inductively coupled to the secondary of transformer T3. The input signal is developed across the secondary of T3 and gain adjust control R24 and applied to the base of transistor Q3. Amplifiers Q3 and A4 are identical with amplifiers Q1 and Q2 in the transmit section of the line amplifier (*b* above).

179. Ring Generator (fig. 181)

a. General. The ring generator produces a 20-cps ringing voltage and a 5-cps flasher signal. The 20-cps ringing voltage is used by the operator for signaling pts and Army. The 5-cps flasher signal is applied to a pushbutton indicator lamp and indicates to the operator the origin of an incoming call. The flasher and signal generator are energized by RING switch S14 or one of the incoming call relays.

b. Circuit Function. The ring generator consists of synchronous motor B1 and switches S19 and S20. Power is applied to motor B1 through the contacts of relay K26. Relay K26 is energized by RING switch S14 or one of the incoming call relays (para. 171). A resistance-capacitance (rc) network, consisting of capacitor C10 and resistor R105, shifts the phase of the a voltage applied to one of the motor windings. Motor B1 drives two magnetic shunt wheels. One wheel, placed between switch S19 and the magnet, contains six shunt vanes. The other wheel, placed between switch S20 and the magnet, contains two shunt vanes. The magnetic field produced by the magnet closes the contacts of S19 and S20. As the shunt wheels are rotated by motor B1, the vanes of the wheel interrupt or shunt the magnetic field, permitting the switch contacts to open.

(1) *20-cps ringing voltage.* The 20-cps ringing voltage is produced by the opening and closing of switch S19. An input of 250 volts is applied between TB1–5 and TB1–6. The voltage applied to switch S19 is maintained at 200 volts by Zener diode CR45. The 20-cps output between TB1–1 and TB1–9 is approximately 100 volts. When connected to an external load the output is reduced by the drop across resistor R104. If more than one



TES:
1. UNLESS OTHERWISE INDICATED:
ALL RESISTANCE VALUES ARE IN OHMS
ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
2. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE

J9 OR J10
JACK MATES WITH PRINTED CIRCUIT CONNECTOR PLUG

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Figure 18. Line amplifier circuit board, schematic diagram.

field telephone is connected to a circuit this voltage will be further reduced.

Note. When the 20-cps ring voltage is used to operate the mechanical white flag indicator in the SB-22 field switchboard it may be necessary to reverse the line leads. The con-

trol panel provides pulsating dc only. The switchboard line-pack indicators have internal series diodes and operate with only one line polarization. Either reverse the leads as required or add a large capacitor in series with the line when operating with the SB–22.

(2) *5-cps flasher signal.* The 5-cps flasher signal is produced by switch S20. Ground is applied to TB1–10 through the contacts of S20. The output at TB1–10 applies ground to a pushbutton indicator lamp, causing the lamp to flash at a 5-cps rate. The signal is applied to the proper lamp by associated incoming call relays.

180. Detector, 20-Cps
(fig. 19)

a. General. An incoming 20-cps ringing voltage from the Army line, pts discrete line, or spare line is applied to the associated control panel 20-cps detector circuit board. The incoming ring voltage is detected and amplified and triggers a relay control transistor which, in turn, energizes the associated incoming call relay. Contacts of the relay apply a 1,600-cps signal to the monitor amplifier and control panel loudspeaker to alert the operator. Another set of contacts applies a 5-cps flasher signal to the pushbutton associated with the calling party to indicate which line is calling in.

b. Amplifier Q1. With no input applied between pins 2 and 3 of plug P4, transistor Q1 conducts and, in turn, biases relay control transistor Q2 to cutoff. Base bias voltage for Q1 is furnished by voltage divider R3, R4, and R27. Transistor Q1 is controlled by a detector circuit consisting of diodes CR2 and CR3 and capacitor C1. Ringing voltage from the pts discrete line is applied between pins 2 and 3 of plug P4. When the input voltage increases to an amplitude of approximately 6.2 volts, Zener diodes CR1 and CR2 conduct, applying an input voltage to the detector circuit. On the positive swing of the input signal, capacitor C1 charges through diode CR2. After several cycles of operation (causing a slight time delay), capacitor C1 charges to approximately the peak value of the applied signal. The potential developed across capacitor C1 is sufficiently positive to cu off amplifier Q1.

c. Relay Control Q2. With no input signal relay control transistor Q2 is biased to cutof by the output of amplifier Q1. With an inpu signal applied, amplifier Q1 is cut off, remov ing the bias from relay control Q2, and per mitting the transistor to conduct. Collector cur rent of relay control Q2 flows through the coi winding of the associated incoming call rela and energizes the relay.

d. Amplifiers Q3 and Q5. Amplifiers Q3 an Q5 operate in the same manner as amplifier Q (*b* above).

e. Relay Control Q4 and Q6. Relay contro transistors Q4 and Q6 operate in the same man ner as Q2 (*c* above). Relay control transisto Q4 controls K11 (Army) and Q6 controls K1 (spare line).

181. Oscillator, 1,600-Cps
(fig. 20)

a. General. The 1,600-cps oscillator produce an output signal for use as a signaling tone fo the command radio circuit and as a test signal The 1,600-cps oscillator circuit board consist of an oscillator and two amplifier stages.

b. Oscillator Q1. Transistor Q1 and the asso ciated circuit make up a Colpitts oscillator. A tank circuit, consisting of variable inductor L and fixed capacitors C1 and C2, is tuned to 1, 600 cps. Feedback voltage is obtained from capacitive voltage divider C1 and C2. The out put signal developed across resistor R12 i coupled to pin B of plug P8 through capacito C5 and level control R11. This signal is applie to the monitor amplifier through contacts of th incoming call relays. The output signal is als applied to amplifiers Q2 and Q3. Bias voltag for the base of Q1 is furnished by voltage di vider R1 and R2.

c. Test Signal Amplifier Q2. The output from oscillator Q1 is applied to the base of Q through C3 and developed across R4. Bias volt age for the base of Q2 is furnished by voltag divider R4 and R5. The emitter of Q2 is con nected to TEST SIGNAL LEVEL control R9

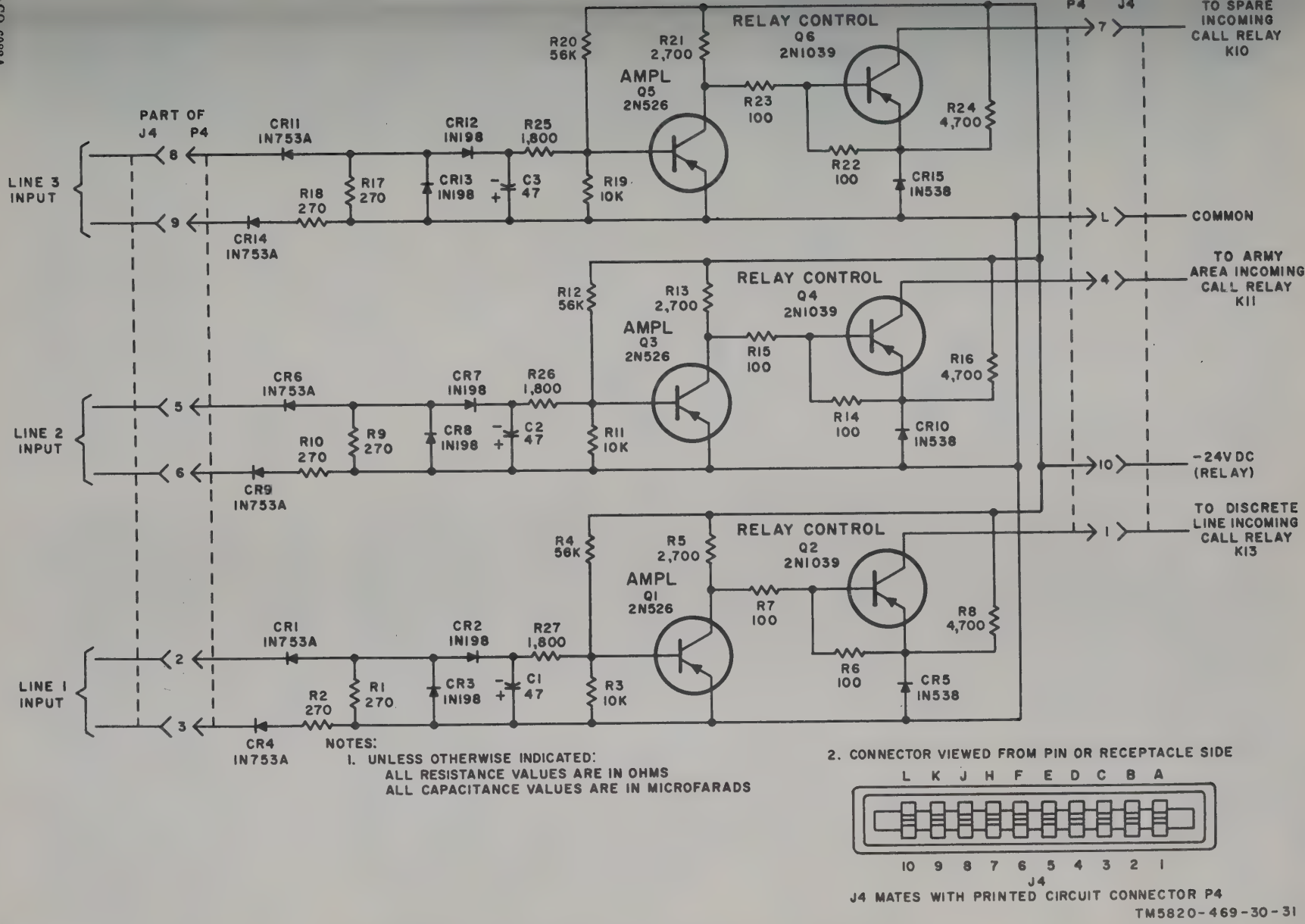


Figure 19. 20-cps detector circuit board, schematic diagram.

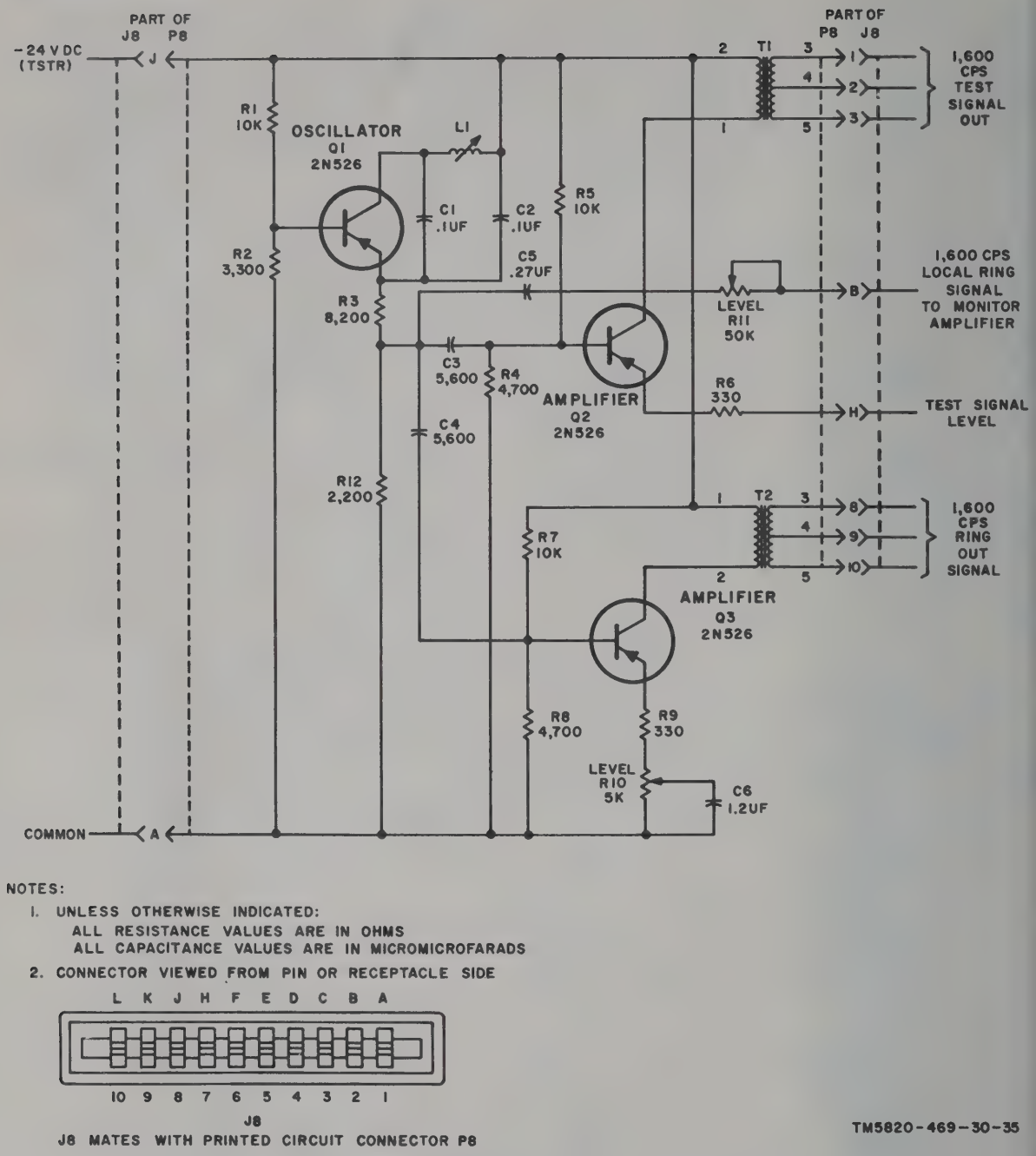


Figure 20. 1,600-cps oscillator circuit board, schematic diagram.

located on the front of the control panel. The amplified output signal developed across the primary winding of transformer T1 is inductively coupled to the secondary of T1. The signal developed across the secondary winding of T1 is applied to TEST SIGNAL switch S1 through pins 1 and 3 of plug P8.

d. Ring-Signal Amplifier Q3. The outpu from oscillator Q1 is applied to the base of Q through capacitor C4. Bias voltage for the bas of Q3 is furnished by voltage divider R7 an R8. The gain of Q3 is determined by the settin of level adjust control R10. The amplified out put signal developed across the primary wind

ıg of transformer T2 is inductively coupled to ıe secondary of T2. The signal developed cross the secondary winding of T2 is applied) the command ring-out relay.

82. Detector, 1,600-Cps
(fig. 21)

a. General. A 1,600-cps signaling tone from he distant radio set is used to ring the local perator. This tone is detected and amplified by he 1,600-cps detector. The output of the 1,600-ps detector energizes the command incoming all relay which, in turn, applies a tone from he 1,600-cps oscillator to the monitor amplifier.

b. Amplifier Q1. The signal from the radio eceiving system is applied to transformer T1 hrough pins 10–L and 9–X of plug P7. The ignal is inductively coupled to the secondary vinding. Back-to-back connected diodes CR4 nd CR5 limit the level of the signal. The sig-ıal applied to the pickoff arm of level adjust R1 is applied to the base of Q1 through capaci-or C1. Base bias voltage for Q1 is furnished by oltage divider R2, R3, and R9. Resistor R5, ypassed by capacitor C3, provides bias stabili-ation. Unbypassed resistor R4 provides a small mount of emitter degeneration for gain stabi-ization. A tuned circuit, consisting of inductor L1 and capacitor C10 in the collector circuit of Q1, is tuned to 1,600 cps by L1. The amplified 1,600-cps output of Q1 is applied to emitter ollower Q2 through capacitor C2.

c. Emitter Follower Q2.

(1) Base bias voltage for emitter follower Q2 is furnished by voltage divider R6 and R7. The output signal is developed across emitter resistor R8 and coupled through capacitor C5 to the detector circuit. The output is also coupled through capacitor C4 to test point TP1.

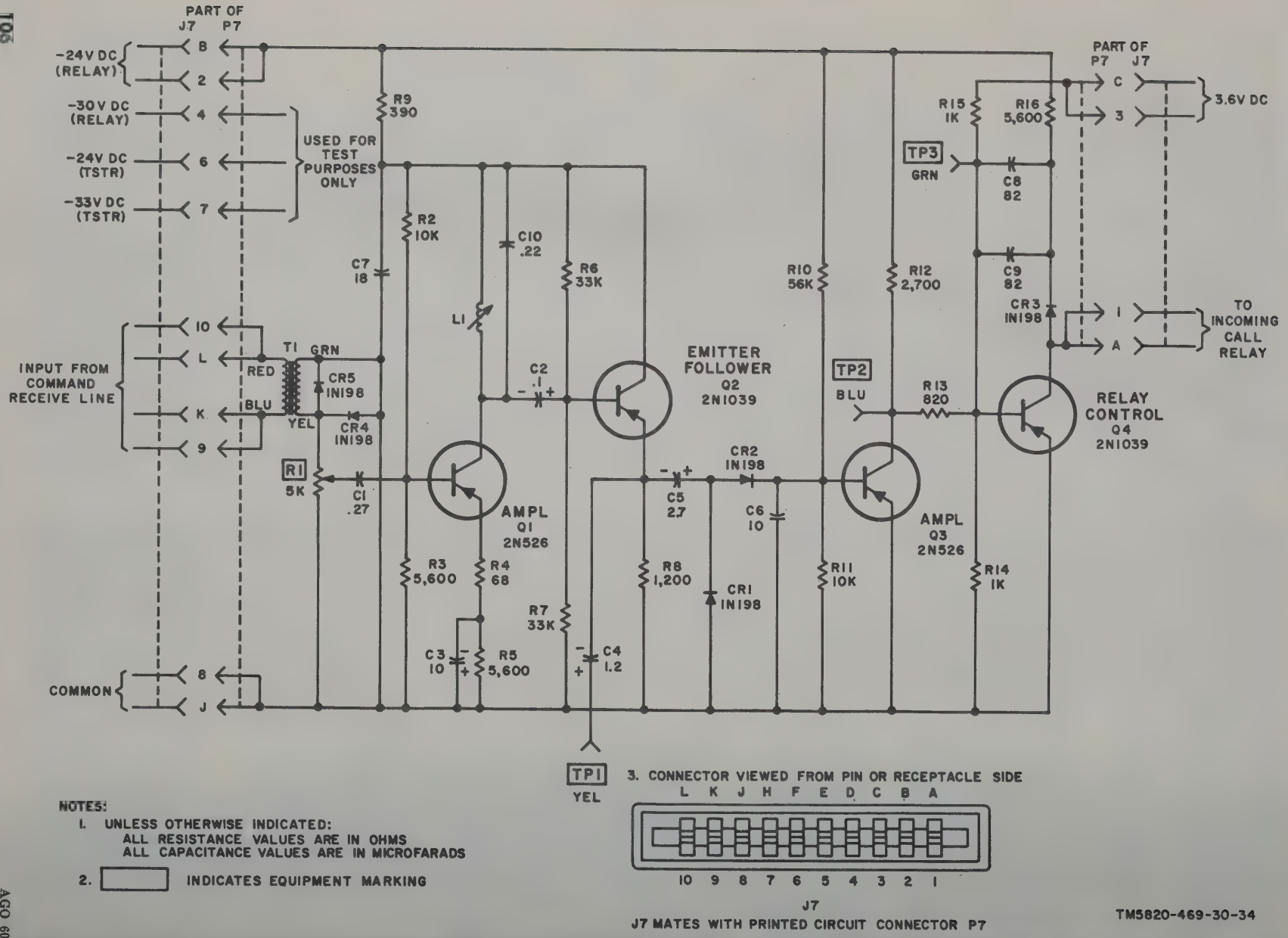
(2) The detector circuit consists of diodes CR1 and CR2 and capacitor C6 connected as a rectifier-doubler. As the output of Q2 swings in the negative direction, capacitor C5 charges through diode CR1 and resistor R8. As the output of Q2 swings in the positive direction, capacitor C5 discharges through resistor R8, capacitor C6, and diode CR2. Capacitor C6 charges to the applied voltage. During sequential cycles of operation, capacitor C6 charges to approximately the peak-to-peak value of the input signal because of its high-impedance discharge path. The potential developed across capacitor C6 from an applied 1,600-cps signal is sufficiently positive to cut off amplifier Q3.

d. Amplifier Q3. With no signal input to the detector, amplifier Q3 is conducting due to the forward-biasing base voltage furnished by voltage divider R10 and R11. The output voltage developed across load resistor R12 is applied to relay control Q4 through resistor R13. With a 1,600-cps input to the detector, Q3 is cut off by the positive voltage developed by the detector circuit (*c* above) and a negative voltage is applied to relay control transistor Q4.

e. Relay Control Transistor Q4. With no signal input to the detector, relay control transistor Q4 is cut off by a positive voltage applied to the base circuit from the 3.6-volt dc supply applied to pin 3–C of plug P7. When the 1,600-cps signal tone is applied to the detector, the negative dc output voltage of Q3 (*d* above) exceeds the positive bias applied to the base of Q4, and permits Q4 to conduct. An increase in collector current of Q4 is delayed by capacitors C8 and C9 and diode CR3. This delay is to prevent spurious radio receiver signals from triggering relay control Q4. Collector current of Q4 energizes the incoming call relay.

183. Monitor Amplifier
(fig. 22)

a. General. MONITOR switches are provided on the control panel for monitoring received signals. When a MONITOR switch is closed, voice signals are coupled through an impedance-matching network to the monitor amplifier card. The signals are amplified and applied to a speaker. The incoming ring signal from the 1,600-cps oscillator is also applied to the monitor amplifier.



NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROFARADS
2. ▭ INDICATES EQUIPMENT MARKING

Figure 21. 1,600-cps detector circuit board, schematic diagram.

b. Input Circuit. The received voice signals elected by the MONITOR switch are applied etween pins L and K of plug P6 and induc-ively coupled to the secondary of impedance-natching transformer T1. High-frequency com-ensation in the secondary of T1 is provided by apacitor C1.

c. Amplifier Q1. Incoming voice signals de-eloped across the secondary of transformer '1 are coupled to the base of Q1 through ca-acitor C2. The 1,600-cps incoming ring signal s direct-coupled to the base of Q1. Base bias oltage for Q1 is furnished by voltage divider 1 and R2. Resistor R5, bypassed by capacitor 3, provides bias stabilization. Unbypassed re-istor R4 provides a small amount of emitter legeneration for gain stabilization. The ampli-ied signal developed across load resistor R3 s applied to amplifier Q2 through capacitor C4.

d. Amplifier Q2. The output of Q1 is applied o the base of amplifier Q2. Base bias voltage or Q2 is furnished by voltage divider R6 and 7. Resistor R10, bypassed by capacitor C5, rovides bias stabilization. A small amount of mitter degeneration is provided by unbypassed esistor R9 for gain stabilization. The ampli-ied output developed across load resistor R8 is pplied to emitter-follower Q3 through capaci-or C6.

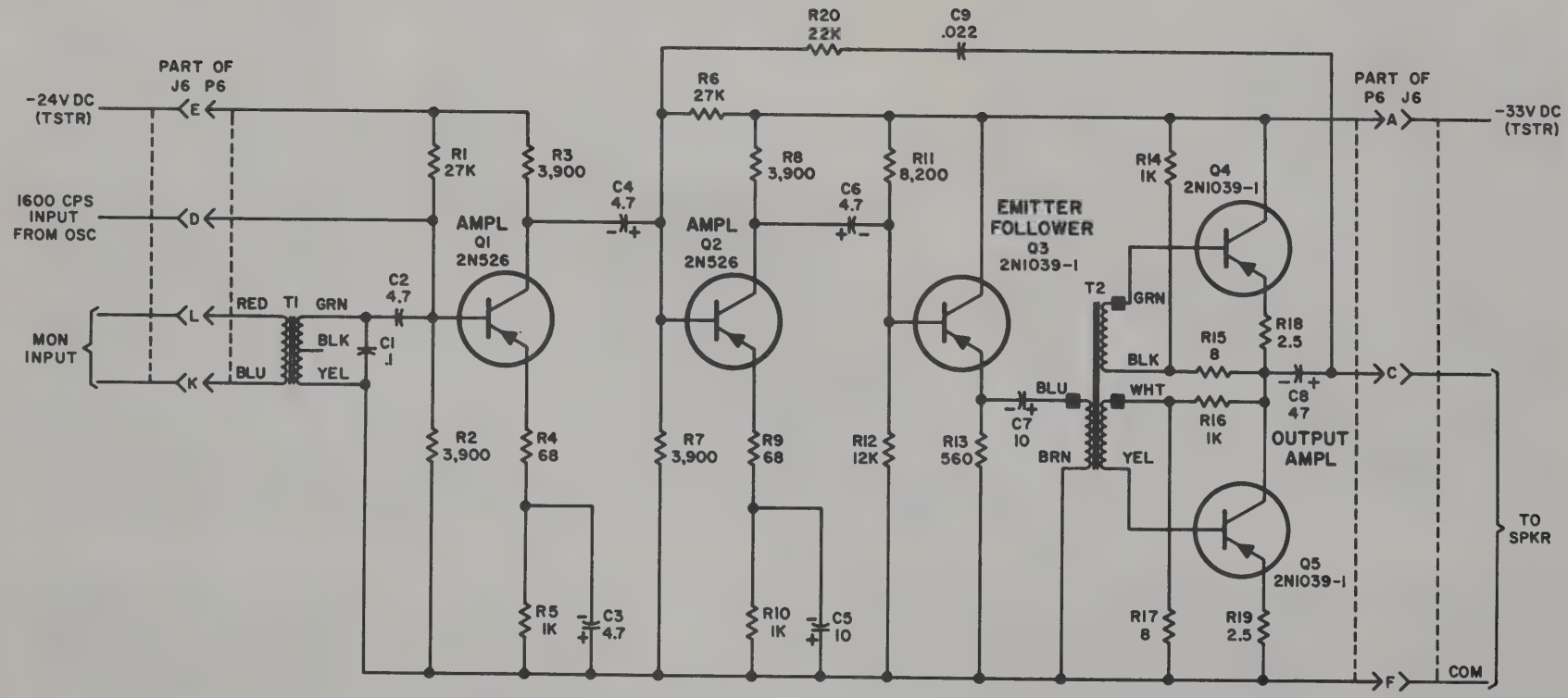
e. Emitter-Follower Q3. Emitter-follower Q3 natches the output impedance of amplifier Q2 o the input impedance of transformer T2. Base bias voltage for Q3 is furnished by volt-ge divider R11 and R12. The output signal de-eloped across emitter resistor R13 is applied o the primary of transformer T2 through ca-acitor C7.

f. Output Amplifiers Q4 and Q5. The output ignal from emitter-follower Q3 is inductively oupled to the secondaries of transformer T2. One secondary of T2 drives Q4; the other sec-ndary drives Q5. Base bias voltage for Q4 and 5 is furnished by voltage divider R14 through 17. With no applied signal, transistors Q4 nd Q5 are conducting. As the signal applied to he primary of T2 swings in a negative direc-ion, the base-to-emitter voltage of transistor 4 increases in the negative direction, allowing transistor Q4 to conduct. The base-to-emitter voltage applied to transistor Q5 increases in the positive direction and tends to drive Q5 toward cutoff. However, the rise in voltage across R17 and R16 (because of increased conduction of Q4) prevents Q5 from being driven toward cutoff, and the current flow is not reduced. The voltage increase across resistors R17 and R16 is coupled through capacitor C8 to the speaker. As the applied signal swings in the negative direction, the conditions of transistors Q4 and Q5 reverse, the output signal voltage drops, and Q5 is driven toward saturation. The output signal is coupled through capacitor C8 and pin C of plug P6 to the speaker. Part of the input signal is also applied to the base of amplifier Q2 (*d* above) through feedback network C9 and R20. This feedback signal stabilizes the gain of the monitor amplifier and improves the frequency response.

184. Teletypewriter Priority Circuit (fig. 23)

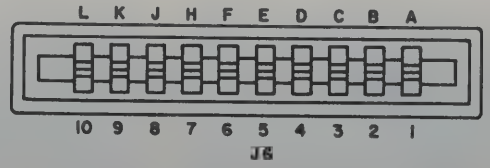
a. General. Information transmitted from the local tty is applied to the local tty printer through a hybrid network. The level of the local self copy tty signals is not sufficient to operate the tty priority circuit. If the local terminal is transmitting, and the distant terminal starts transmitting, the local printer is automatically switched by the tty priority circuit to print the incoming information from the distant terminal. Incoming tty signals applied to the tty priority circuit are amplified and detected, and the output is used to energize tty priority relay K23. The contacts of K23 remove the local tty signal from the printer and apply the incoming signals to the printer.

b. Amplifier Q1. The incoming VF tty signals are applied between pins 10–L and 9–K of plug P5 and inductively coupled through transformer T1. The signal at the pickoff arm of level adjust control R1 is applied to the base of amplifier Q1 through capacitor C1. Base bias voltage for Q1 is obtained from voltage divider R2 and R3. Resistor R5, bypassed by capacitor C3, provides bias stabilization. A small amount of degeneration is developed across emitter resistor R4 for gain stabilization. The amplified



NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
2. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



J6 MATES WITH PRINTED CIRCUIT CONNECTOR P6

TM5820-469-30-32

Figure 22. Monitor amplifier circuit board, schematic diagram.

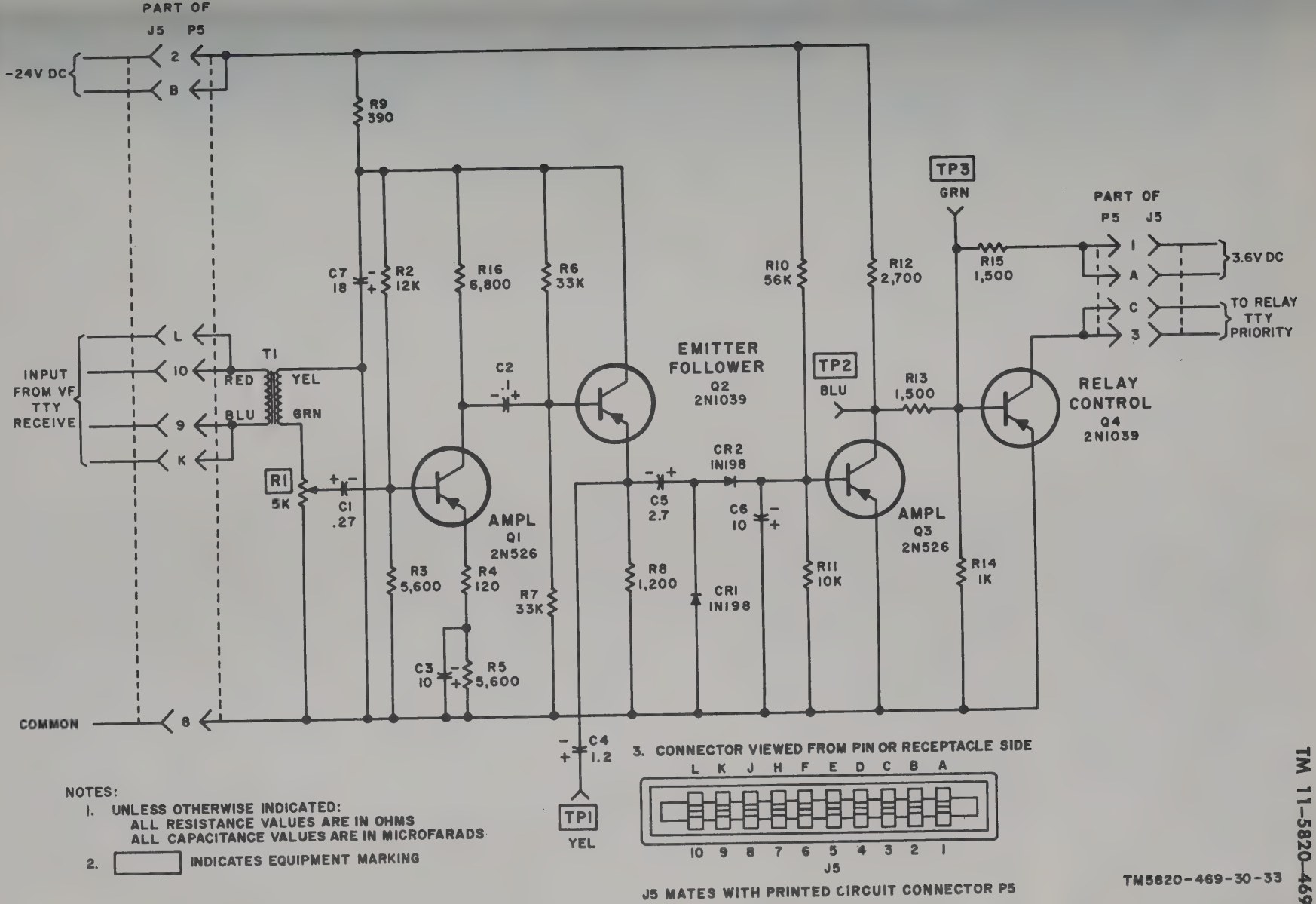


Figure 23. Tty priority circuit board, schematic diagram.

output developed across load resistor R16 is applied to emitter-follower Q2 through capacitor C2. Resistor R9 and capacitor C7 serve as a decoupling network.

c. Emitter-Follower Q2 and Amplifier Q3. Emitter-follower Q2 and amplifier Q3 are identical with corresponding stages of the 1,600-cps detector and are covered in paragraph 182*c* and *d*.

d. Relay Control Q4. With no signal input to the tty priority circuit, relay control transistor Q4 is biased to cutoff. With a signal input to the tty priority circuit, amplifier Q3 is driven to cutoff. The voltage at the collector of Q3 becomes negative and is applied to the base of Q4. This exceeds the bias voltage at the base of Q4 (developed by resistors R14 and R15) and drives Q4 into saturation. The coil of tty priority relay K23 is series-connected with the collector of Q4 and is energized when Q4 conducts.

185. Power Supply
(fig. 181)

The necessary operating potentials for the control panel are provided by the main chassis power supply section.

a. Input Circuit. An input source of 120-volt, single-base, 400-cps voltage (60-cps primary power *cannot* be used) is applied to transformer T1 through pins L and M of jack J2 and POWER switch S13. Protection for the input circuit is provided by slow-blow fuse F3. Fuses F1 and F2 protect the transistorized circuits.

b. Relay and Transistor Supply. The ac power source is inductively coupled to the secondary of transformer T1. The output of T1 is applied to full-wave rectifier CR41 and CR42. The rectified output is filtered by capacitor C2.

(1) *Relay supply.* The rectifier output is dropped to a regulated —24 volts by voltage-dropping resistors R99 and R100 and parallel-connected series regulators Q2 and Q3. Fuse F2 protects this circuit against current overloads. Transistors Q2 and Q3 maintain the output constant at a voltage determined by Zener diode CR33. Voltage divider network CR33 and R101 provides a constant potential for the bases of transistors Q2 and Q3. Output variations are detected by the emitter circuits which, in turn, increase or decrease the internal resistance of the regulator transistors, depending on the correction required. The internal resistance of the transistors is in parallel with series resistor R100. Another output is taken from the full-wave rectifier through series resistor R102 to supply —30 volts as a relay supply. Zener diode CR30 provides regulation of this output.

(2) *Transistor supply.* Another output from full-wave rectifier CR41 and CR42 is used as the transistor supply. Protection of this circuit is provided by fuse F1. The supply provides regulated outputs of —33 volts dc and —24 volts dc. Transistors Q4 and Q5 provide regulation, and capacitors C7 and C8 provide filtering. Zener diode CR38 maintains the base of Q4 at a constant potential of approximately —33 volts. The dc output voltage across C7 is determined by voltage-dropping resistor R115 and the effective load of the circuits connected. Zener diode CR39 prevents the voltage across C7 from rising above 27 volts. This condition could occur when several plug-in circuit boards are removed.

(3) *Transistor bias.* An ac voltage from the secondary of transformer T1 is coupled through surge resistor R113 to half-wave rectifier CR36. The ac is rectified by CR36, and filtered by capacitor C3. Resistor R114 and Zener diode CR37 provide a regulated +3.6-volt dc output.

c. 250-Volt Dc Output Supply. The ac primary voltage from terminal 1 of transformer T1 is applied to TB1 terminal 4 of the ring generator. The ac source is coupled through

ontacts of relay K26 (energized by RING witch S14 or incoming call relays) to TB1 erminal 8. From this point, the ac voltage is pplied through surge resistor R97 to the recti- ier circuit. The ac signal is rectified by CR34 and CR35. The output is taken across a voltage-doubler circuit consisting of capacitors C4 and C5 and resistors R111 and R112. The dc output is applied through the ring generator as the ringing voltage source.

CHAPTER 11

FUNCTIONING OF TELETYPEWRITER SWITCH PANEL

86. General
(fig. 182)

The teletypewriter switch panel consists of a ybrid network, a balancing network, and witches that control the mode of teletypewriter peration and the shelter lighting switch. No ctive components are located within this panel. he function of the teletypewriter switch panel n relation to other units of the radio set is overed in paragraphs 147 through 176. The aragraphs in this chapter cover the function f the internal components within the teletype- riter switch panel and the signal routing in ne three positions of OPERATING MODE witch S2 (para. 188).

87. Hybrid Network
(fig. 182)

a. A hybrid network is used for the VF tty ignals between pts and the radio set multi- lexer. The hybrid circuit provides low atten- ation paths between certain circuits and pro- ides isolation between others. Hybrids are re- uired when separately amplified signals are eing transmitted in both directions over a wo-wire line. Hybrids are also required when perating from a two-wire line into a four-wire ine.

b. The hybrid network of the teletypewriter witch panel consists of two-section trans- ormer T1 and capacitors C1 and C4. The pri- nary windings of each section are joined by apacitors C1 and C4 to form a single ac wind- ng for signal voltages. The secondary windings re connected so that the outer windings (transmit) are connected in series aiding, and he inner windings (receive) are connected in eries opposing. Thus, signals applied to either vinding cancel out in the other, but each signal will appear in the primary winding of both the balancing network and the two-wire line. Signals received from the two-wire line appear across both the transmit and receive lines but are canceled out of the balancing network.

c. The two-wire line from pts is connected between terminals P and L of T1. The transmit output is taken between terminals U and E. The receive signal is applied between terminals T and H. The balancing network is connected between terminals A and D. The balancing network is used to match the impedance of the two-wire line and prevent crosstalk between the transmit and receive windings. Three-position switch (REMOTE DISTANCE) S2 balances the hybrid circuit and matches the hybrid impedance to the impedance of the line. In the SHORT position, resistor R1 is adjusted to match the impedance of a line approximately one-quarter mile in length. In the MED position, resistor R2 is adjusted to match the impedance of a line one-half to three-quarters of a mile in length. In the LONG position, R3 is adjusted to match the impedance of a line of 1 mile or over.

188. Operational Switches
(fig. 182)

OPERATING MODE switch S2 and PTS-BY PASS switch S1 are used to select operating modes and type of connections. These switch functions are described in *a* and *b* below.

a. OPERATING MODE Switch S2. The mode of operation for the teletypewriter switch panel is selected by switch S2. The following circuit arrangements are made in the switch positions listed below:

(1) *LINE TEST* (fig. 24). Figure 24 illustrates the connections made through

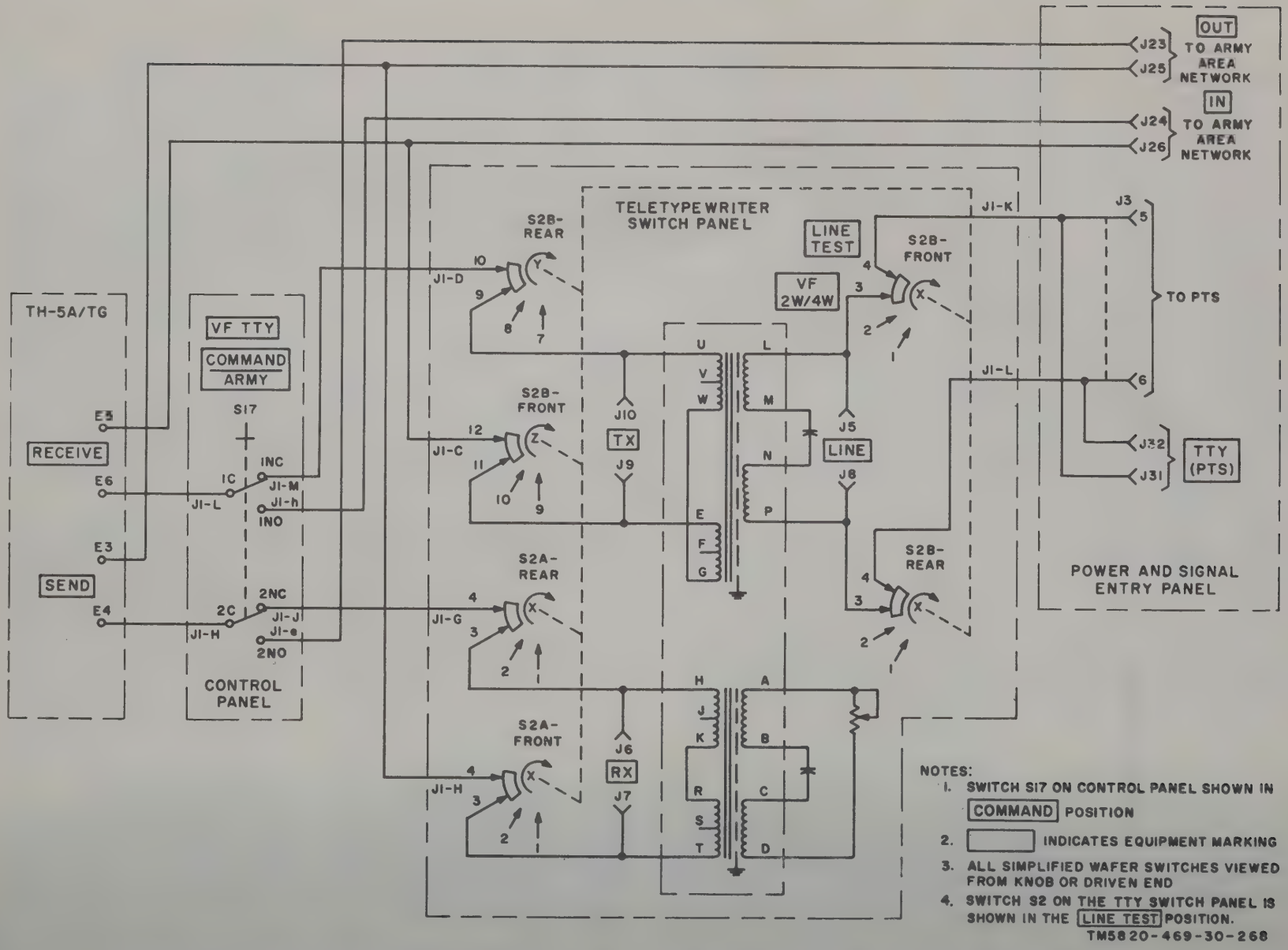


Figure 24. Teletypewriter switch panel, circuit connections with S2 in LINE TEST position, simplified schematic diagram.

switch S2 when it is set to LINE TEST. The LINE TEST position is used during adjustment of the balancing network of the hybrid (para. 187). This switch position permits a tone from the telegraph terminal to be applied (terminals E3 and E4 of the TH–5A/TG) (fig. 24) through the normally closed contacts of S17 in the control panel, through the contacts of S2A, to windings H and T of the hybrid transformer. This switch position also permits the tone from the two-wire line to be applied to the pts line.

(2) *VF 2W/4W* (fig. 16). This position of the switch routes the VF tty signals to and from pts through the hybrid network, and to and from the multiplexer. Figure 16 is a simplified schematic diagram of the circuit connections that are completed when S2 is in the VF 2W/4W position.

(3) *NORMAL DC LOOP* (fig. 17). This switch position routes the local tty signals to and from the multiplexer, bypassing the hybrid network. Figure 17 is a simplified schematic diagram of the circuit connections that are completed when S2 is in the NORMAL DC LOOP position.

b. PTS-BY PASS Switch S1. When operating in the NORMAL DC LOOP mode (*a*(3) above), pts is connected into the loop by setting PTS-BY PASS switch S1 to OFF. When switch S1 is set to ON, the pts loop circuit is short-circuited.

189. Teletypewriter Switch Panel Power Circuit (fig. 182)

The primary power source (120 volts 400 cps only) is applied to jack J4. From pins C and E of J4, the primary power is applied through jacks J2 and J3 to the TH–5A/TG and the TT–335/TG. Also, from pin B of jack J4, primary power from an interlock circuit (in series with the shelter door light interlock circuit) is applied through F1 and switch S4 to transformer T2. The positioning of switch S4 determines the intensity of the shelter lights by selecting different taps on the primary of T2.

CHAPTER 12

FUNCTIONING OF POWER DISTRIBUTION PANEL SB–1565/TRC–80

0. General

Power Distribution Panel SB–1565/TRC–80 tch panel) is the power control center for AN/TRC–80. Air failure indicator lamps the rack blowers, and switches that control k power, rack blowers, hut lights, and flush- blower are located in the switch panel. nper cables and jacks for cable patching are luded on the switch panel to provide versa- ty of terminal control in space-diversity ration. A selector switch is provided for al, parallel, or remote operation of the multi- xer and modulator-multiplier units. Another ector switch on the switch panel selects the /TRC–80 to be used as the control shelter ing space-diversity operation and also per- ts changing control after operation has be- n. Circuit details are covered in paragraphs through 194.

1. Power Control (fig. 183)

Rack power (not including the power for the wer amplifier cabinet) is routed through the itch panel. There are switches for the three k blowers, hut lights, and the flushing wer for the engine generator compartment.

a. Rack Power. Phases 1, 2, and 3 from the wer source are applied to jack J13 through s M–P, W–R, and X–S, respectively. The ee phases of power are applied to RACK WER switch S1. When this switch is closed, wer is applied to the power supplies located racks 1 through 5 and to indicator lamp DS7 rough current-limiting resistor R7.

b. Rack Blowers. Phase 3 of the input source also applied to RACK BLOWERS switch S6. hen switch S6 is closed, power is applied to e blowers in racks 1, 3, and 4. These blowers provide cooling for components located on these racks. When the air switches (located in the rack blowers) close, AIR FAILURES lamps DS1, DS2 and DS3 are extinguished. If a blower fails in one of the racks, the corresponding air failure lamp for that rack is lighted.

c. Hut Lights. Phase 1 is also applied to HUT LIGHTS switch S4. When this switch is closed, operating potential is applied to the overhead lights of the hut and through current-limiting resistor R4 to indicator lamp DS4.

d. Flushing Blower. Phase 2 is also applied to FLUSHING BLOWER switch S5 through fuse F2. When switch S5 is closed, power is applied to the blower contactor and through current-limiting resistor R5 to DS5.

192. Selector Switch S1 (fig. 183)

When two radio sets (emplaced approximately 30 feet apart) are used in space-diversity operation, only one multiplexer unit and one modulator-multiplier is used. Selector switch S1, labeled DEMULT-MULT-MOD, selects the multiplexer and modulator-multiplier units of radio set 1 *or* radio set 2.

a. Local Operation. When only one radio set is used, selector switch S1 is set to LOCAL. The audio and tty output of the local multiplexer is applied to the local modulator-multiplier through contacts 9 and 10 of S1A (rear).

b. Parallel Operation. When two radio sets are used in space-diversity operation and the multiplexer of radio set 1 (local set) is used to drive the modulator-multiplier of radio sets 1 and 2 (remote set), selector switch S1 of radio set 1 is set to PARALLEL, and switch S1 of radio set 2 is set to REMOTE. The output of

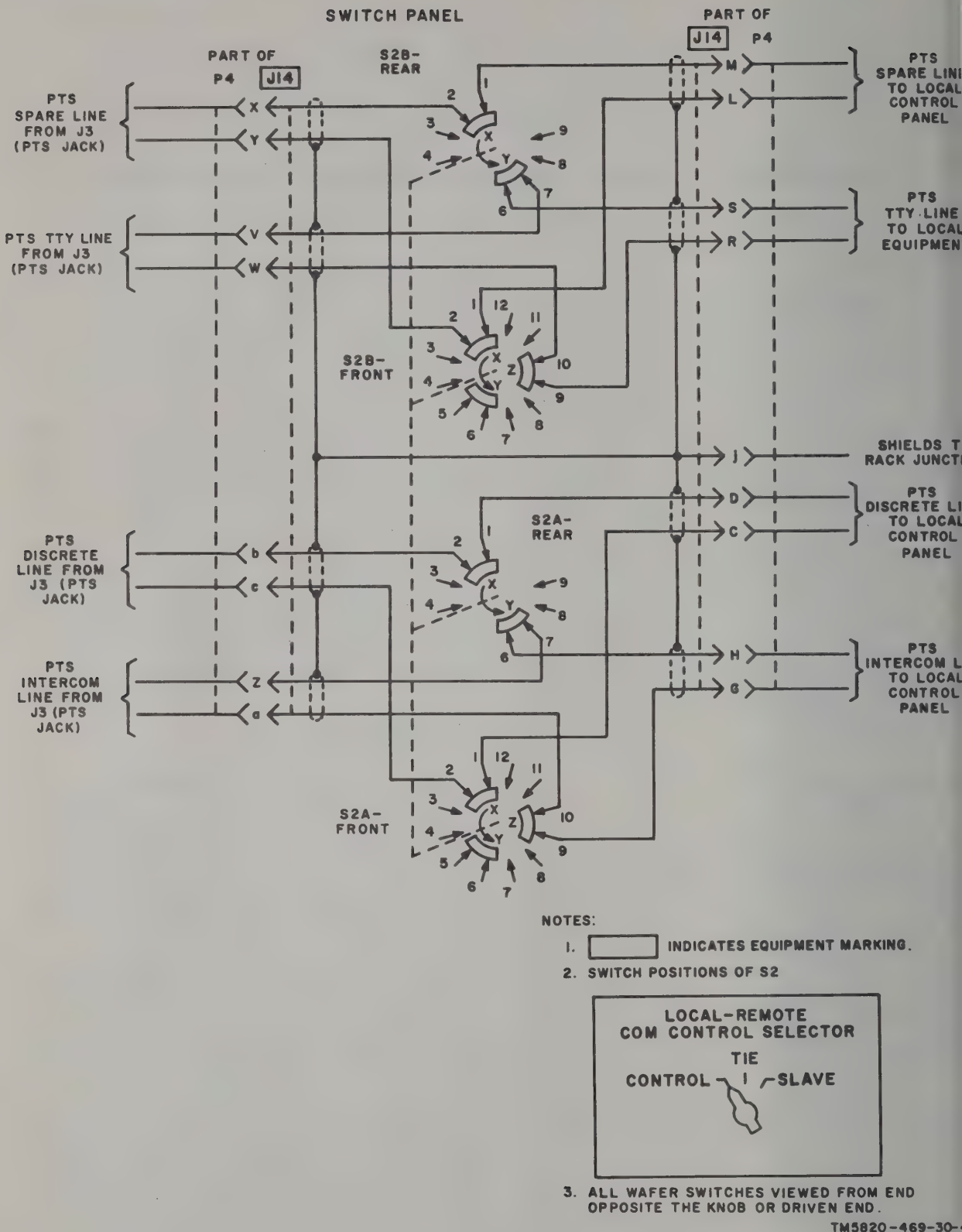


Figure 25. Selector switch S2 with radio set 1 as control set, simplified schematic diagram.

e multiplexer of radio set 1 is applied to pin of jack J14 through contacts 1 and 3 of S1A ront). The output at jack J14 is routed from dio set 1 to radio set 2 interconnecting jack (PACK 1 TO 2 INTERCONNECTION). e output of the multiplexer is also applied to e modulator-multiplier of radio set 1 through ntacts 9 and 11 of S1A (rear).

c. Remote Operation. When the multiplexer radio set 2 (remote set) is used to drive the odulator-multiplier of radio sets 1 and 2, se- tor switch S1 is set to REMOTE in set 1, d to PARALLEL in set 2. The output of the ultiplexer of radio set 2 is applied to pin B jack J14 (radio set 1) through the inter- nnect cable and through contacts 1 and 4 of A (rear) to the modulator-multiplier in dio set 1.

3. Selector Switch S2

When space-diversity operation is used, one dio set is designated as the control set. ormally, the inputs (discrete, intercom, two- re dc tty, and spare lines) are connected to e power and signal entry panel located in the ntrol radio set. If it becomes necessary to vitch control from one radio set to the other, OCAL-REMOTE COM CONTROL SELEC- OR switch S2 transfers control without dis- nnecting the input cable from one radio set d reconnecting it to the other radio set.

a. Radio Set 1 Control (fig. 25). When radio t 1 is in control, LOCAL-REMOTE COM ONTROL SELECTOR switch S2 is set to ONTROL in radio set 1. Switch S2 in radio set may be set to any position. The signals from e power and signal entry panel of radio set 1 e routed through J14 in the switch panel. rom J14, the signals are routed to their des- tinations through the contacts of S2 as shown in figure 25.

b. Radio Set 2 Control (fig. 184). When control of both sets is transferred to radio set 2, switch S2 of radio set 1 is set to TIE, and switch S2 of radio set 2 is set to SLAVE. These switch settings of S2 (in radio sets 1 and 2) cause the input signals that are tied into the power and signal entry panel of radio set 1 to be transferred through the interconnect cable to radio set 2. Refer to the simplified schematic diagram (fig. 184) to trace signal routing through switches S2 in radio sets 1 and 2.

194. Receiver Patching (fig. 183)

a. Coaxial cables carrying 70-mc IF signals from the receive converter of each receiver to the IF amplifier of each receiver are also routed through this switch panel to permit cross connections for diversity operation, for test purposes, and for troubleshooting.

b. When two radio sets are used in space diversity, only one receive converter in each radio set is used. If radio set 1 is in control, the receive converter output of radio set 2 is routed to radio set 1 by the interconnect cable and to the IF amplifier in that unit. For example, the output of the receive converter (rack A5) is applied to jack J1. A jumper cable is connected between OUT NO. 1 jack J8 and REMOTE jack J12. The output from jack J5 is routed over the interconnect cable to radio set 1 and to jack J5 located on the control panel. A jumper cable is connected between REMOTE jack J12 and IF. IN NO. 1 jack J9 or IF. IN NO. 2 jack J11, depending upon which receive converter is used. Refer to paragraph 69 of TM 11–5820–469–10 for operational details of receiver patching.

CHAPTER 13

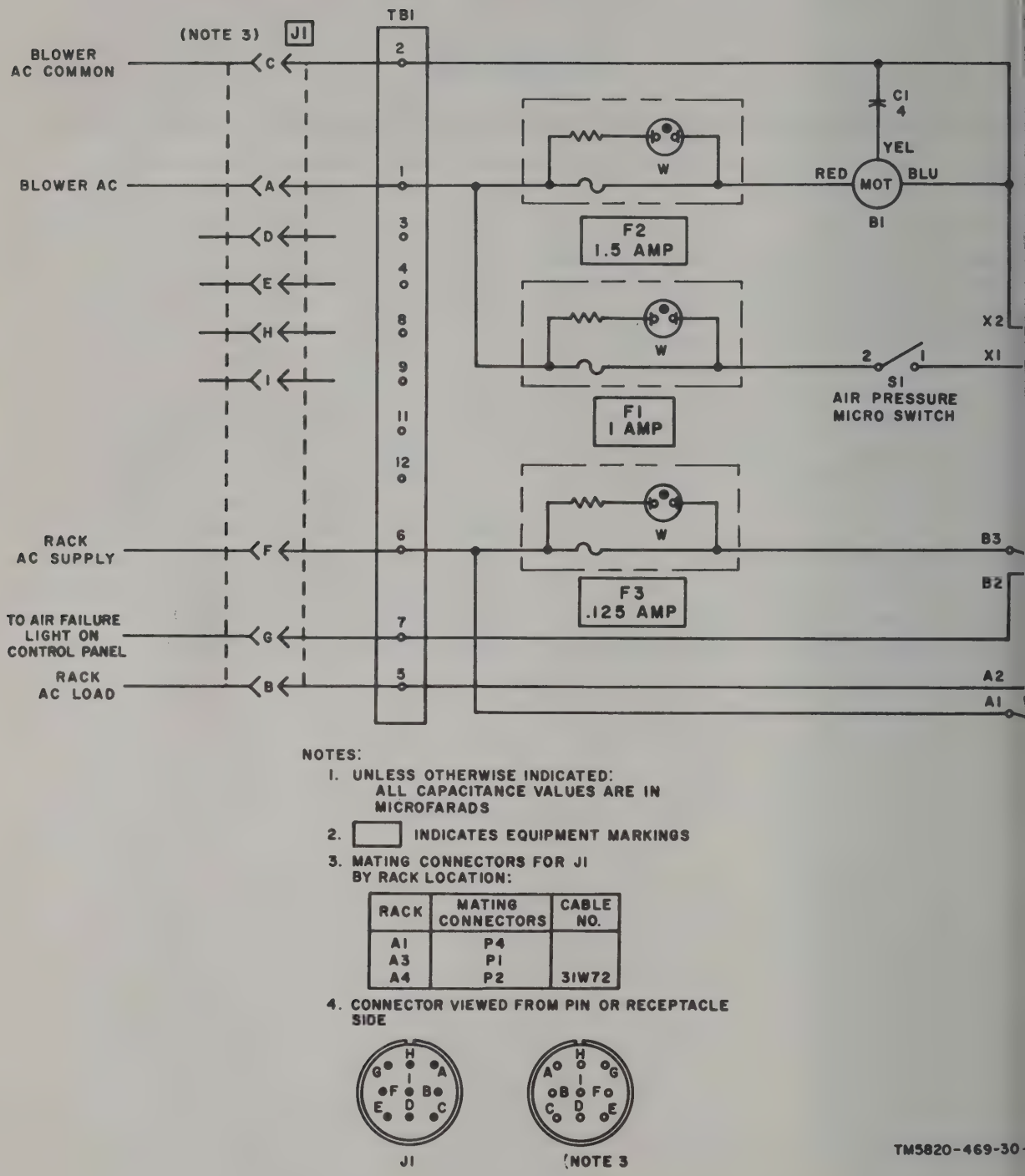
FUNCTIONING OF COOLER, AIR, ELECTRONIC EQUIPMENT HD–545/TRC–80

5. General

Cooler, Air, Electronic Equipment HD–545/ C–80 (blower) is located at the base of ks A1, A3, and A4. The blowers provide ced air cooling to the rack-mounted equipnt. An air-pressure microswitch in the wer housing operates a control relay. The ay controls application of power to the rack ipment and lights the AIR FAILURE lamps, ated on the switch panel, when air pressure reduced.

6. Blower Circuit Description (fig. 26)

Primary power is applied through pin A of k J1 and fuse F2 to the blower motor. Power is also applied through fuse F1 and air-pressure switch S1 to relay K1. Power to the AIR FAILURE indicators is applied through fuse F3 and contacts B2 and B3 of relay K1. Power is applied through contacts A2 and A1 of relay K1 to the rack equipment. When air pressure from the blower reaches a predetermined amount, air-pressure switch S1 closes, energizing relay K1. Contacts B2 and B3 of relay K1 open, removing power from the AIR FAILURE indicators; contacts A1 and A2 close, applying power to the rack equipment. Any time the air pressure drops below the predetermined amount, relay K1 deenergizes, removing power from the rack equipment and applying power to the AIR FAILURE indicators.



NOTES:

1. UNLESS OTHERWISE INDICATED: ALL CAPACITANCE VALUES ARE IN MICROFARADS
2. ☐ INDICATES EQUIPMENT MARKINGS
3. MATING CONNECTORS FOR J1 BY RACK LOCATION:

RACK	MATING CONNECTORS	CABLE NO.
A1	P4	
A3	P1	
A4	P2	31W72

4. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE

TM5820-469-30-

Figure 26. Cooler, Air, Electronic Equipment HD-545/TRC-80, schematic diagram.

CHAPTER 14

FUNCTIONING OF AUDIO FREQUENCY-RADIO FREQUENCY MONITOR MX–4039/TRC–80

7. Monitor Block Diagram (fig. 27)

Audio Frequency-Radio Frequency Monitor X–4039/TRC–80 (monitor) is used for setting the deviation level in the modulator-multiplier and for signal level adjustment in the multiplexer.

b. A 70-mc signal from the modulator-multiplier is heterodyned with a 78-mc local oscillator signal to produce an output of 8 mc. The 8-mc signal is applied through limiter amplifier stages V2, V3, and V4 and cathode follower V5A to a discriminator circuit.

c. Frequency deviation of the 8-mc signal is detected by the discriminator stage. The discriminator output is attenuated and applied to selector switch S2A. Selector switch S2A selects the signal to be monitored (voice deviation or the desired multiplex signal level). The output of switch S2A is amplified by V5B and V6 and applied to a bridge rectifier metering circuit.

d. An internal power supply provides all necessary operating voltages. Transformer T1 provides filament voltages and high voltage. The high-voltage output of T1 is rectified by CR8 through C11, filtered, and regulated by series regulator V7 and voltage regulator V8 and V9. The regulated dc output and the filament voltage are applied to the tube circuits.

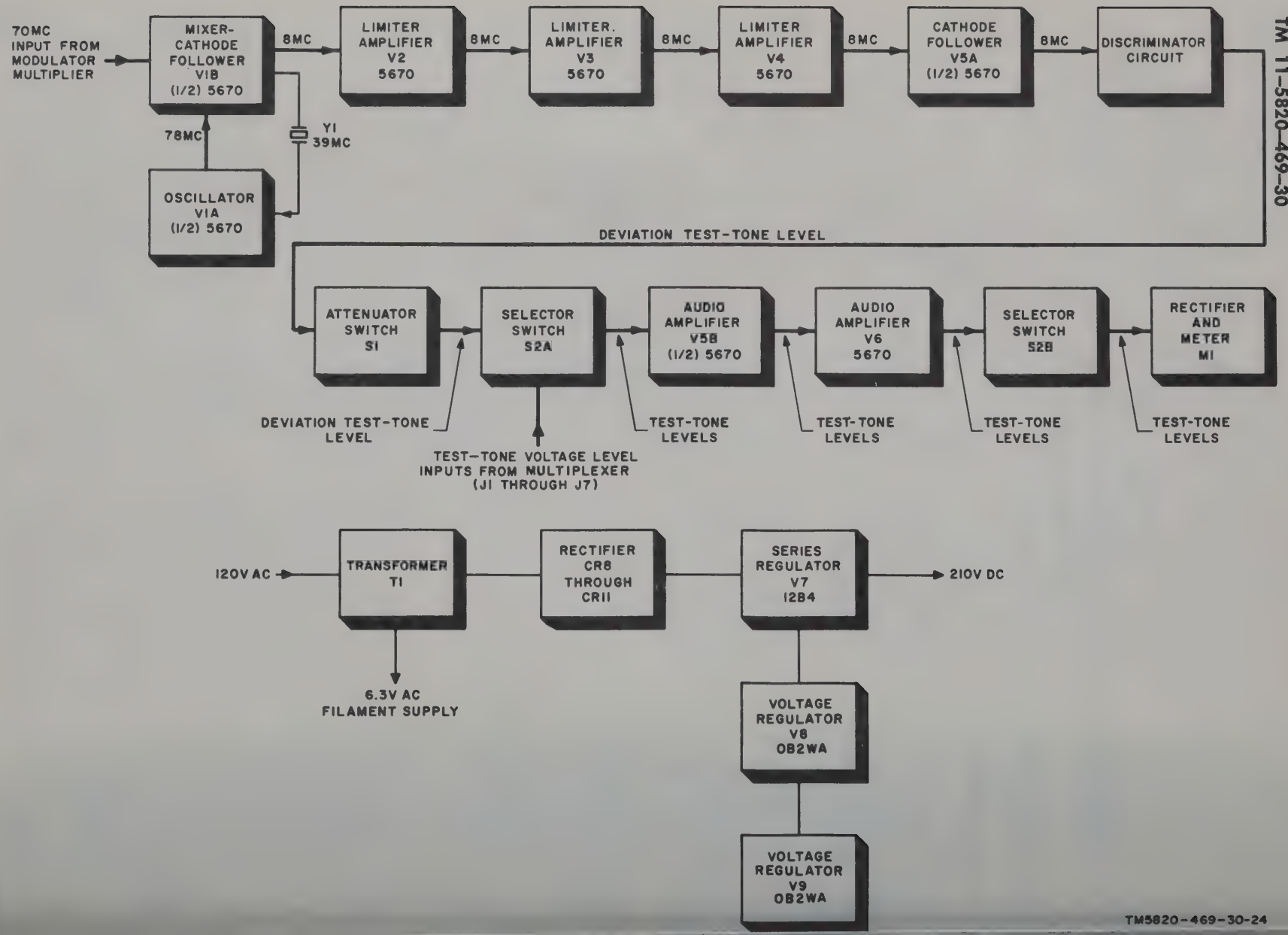
e. Detailed circuit function is covered in paragraphs 198 through 204.

8. Oscillato rand Mixer-Cathode Follower V1 (fig. 185)

Oscillator and mixer-cathode follower stage V1 comprises a two-stage crystal-controlled oscillator and mixer stage. Tube V1A operates as a grounded-grid amplifier and frequency doubler. Tube V1B operates as a cathode follower (at the crystal frequency) and as a mixer stage. The 78-mc output of V1A is mixed with the 70-mc input from the modulator-multiplier to produce an 8–mc output frequency.

a. Oscillator Circuit. Crystal Y1, series-resonant at 39 mc, is connected between the cathode of V1A and the cathode of V1B, and serves as a series-tuned circuit. The crystal output is developed across cathode resistor R26 and applied to the cathode of V1A. The control grid of V1A is grounded at the crystal frequency by capacitor C7. The control grid is returned to ground through resistor R24. A tuned circuit in the plate circuit of V1A, consisting of L4 and C5, selects the second harmonic (78 mc) of the crystal frequency. The 78-mc signal is applied to the control grid of V1B through coupling capacitor C6. The signal at the grid of V1B develops a voltage across resistor R28 that is filtered by R25 and C8 to provide a negative dc voltage at test jack J10 for adjustment purposes. The signal applied to the grid of V1B causes an in-phase signal to be developed across cathode resistor R27 and coupled to the cathode of V1A by crystal Y1 to sustain oscillation.

b. Mixer Circuit V1B. The 70-mc frequency-modulated (fm) signal from the modulator-multiplier (para. 45*a*) is applied to jack J8 and coupled by C1 to the tuned circuit in the plate of V1A. Inductor L2 and capacitor C3, parallel-connected with resistor R25, form an impedance-matching network to match the 50-ohm input impedance of the line. The 70-mc fm signal and the 78-mc oscillator signal are mixed by V1B. The two original frequencies



TM5820-469-30-24

d the sum and difference of the two frencies appear in the plate circuit of V1B. Inctor L3, together with the circuit capaci-nce, is resonant to 8 mc. All frequencies, expt the 8-mc difference frequency, are greatly tenuated. The 8-mc fm signal is developed ross inductor L3 and coupled to the grid of niter amplifier V2 through capacitor C9. Re-tor R30, inductor L1, and capacitors C2 and 0 form plate-decoupling networks.

9. Limiter Amplifiers V2, V3, and V4 (fig. 185)

Under normal signal conditions, V2, V3, and provide amplification for the 8-mc signal; der large signal conditions, V2, V3, and V4 nction as limiters.

a. Amplification, Normal Signal Conditions.

(1) Tubes V2A, V3A, and V4A operate as cathode followers, and V2B, V3B, and V4B function as grounded-grid amplifiers. Except for reference designations, the three stages are identical and only the detailed operation of V2 is covered.

(2) The 8-mc fm signal form V1B is developed across grid resistor R32 and applied through parasitic suppressor resistor R33 to the grid of V2A. The amplified, in-phase, output at the cathode V2A is applied to the cathode of V2B. The signal is amplified and developed across peaking inductor L7 in the plate circuit of V2B. The amplified signal output of V2B is coupled to, and amplified by, limiter amplifiers V3 and V4. Resistors R38 and R47, connected across peaking inductors L8 and L10, broaden the bandpass characteristics of the inductors.

(3) A positive voltage is applied to the grid of V2A by voltage-divider action from R31 and R32. Resistor R35 couples this voltage to the other grid within the dual-triode tube. Coupling between cathode follower V2A and grounded-grid amplifier V2B is provided by common cathode resistor R34. The difference between the voltage across R34 and the positive voltage applied to the grids is the bias for V2. Resistors R33 and R36 are parasitic suppressors. Capacitor C13 grounds the grid of V2B at the signal frequency. Inductor L5 and C11 form a decoupling network for V2A; inductor L6 and C14 are the decoupling network for V2B.

b. Limiting, Large Signal Conditions. Under large signal conditions, V2, V3, and V4 operate as limiters. On the positive swing of the input signal, current flow through the cathode follower stage increases the voltage drop across common cathode resistor R34. This increase in cathode bias cuts off the ground-grid stage, limiting that portion of the input signal. On the negative swing of the input signal, current flow through the cathode follower stage decreases, causing a lower voltage drop across the common cathode resistor. This reduced cathode voltage is applied to the grounded-grid section and causes an increased current flow through the grounded-grid amplifier section. The increase in current flow through the grounded-grid section causes an increase in the voltage drop across the common cathode resistor. As this voltage increases, it tends to cut off the cathode follower section of the tube. This positive and negative limiting action of the limiter amplifier stages removes all large amplitude-modulation variations from the 8-mc fm signal.

200. Cathode Follower V5A and Discriminator Circuit (fig. 185)

a. General. The 8-mc fm signal is applied to cathode follower V5A, amplified, and coupled to the discriminator. The discriminator circuit detects the deviation of the fm signal from the center frequency of the modulator-multiplier and produces a voltage proportional to the amount of deviation. The amplitude of the voltage determines the amount of deviation. The polarity of the voltage determines the direction of the deviation. A positive-going signal is developed if the frequency is above 8 mc, and a negative-going signal is developed if the frequency is below 8 mc.

b. Cathode Follower V5A. The output from limiter amplifier V4 is coupled to grid resistor R51 through capacitor C19. The signal is developed across resistor R51, and is applied through parasitic suppressor R53 to the grid of cathode follower V5A. The grid of V5A is held at approximately +50 volts dc by voltage divider R51 and R54. The output from the cathode of V5A is developed across cathode resistor R52 and applied to the discriminator circuit.

c. Discriminator. The 8-mc fm output of cathode follower V5A is coupled to the discriminator circuit through capacitors C21 and C22. Series resistors R55 and R56 provide isolation between the two tuned circuits and determine the bandwidth. The tuned circuit, consisting of inductor L11 and capacitors C23 and C24, is tuned to 7.8 mc. The tuned circuit, consisting of inductor L12 and capacitors C25 and C26, is tuned to 8.2 mc. When the instantaneous input frequency to the discriminator is below 8 mc, diode CR1 conducts more than diode CR2. The negative voltage developed across resistor R57 is greater in magnitude than the positive voltage developed across resistor R58, and the resultant output voltage is negative. When the instantaneous frequency at the input of the discriminator is above 8 mc, diode CR2 conducts more than diode CR1. The positive voltage developed across resistor R58 is greater in magnitude than the negative voltage developed across resistor R57, and the resultant output voltage is positive. The output voltage is applied to jack J11, for adjustment of the tuned circuits, and through capacitor C29 to attenuator switch S1.

201. Attenuator and Selector Switches (fig. 185)

a. Attenuator Switch S1. Attenuator switch S1 is a two-section, five-position rotary switch that selects a resistive network to attenuate the discriminator output, causing meter M1 to indicate at SET POINT for test-tone deviation. Position A of the switch is the only position used in the present system application. Positions B, C, D, and E of S1 are intended for use in other system configurations. Resistors R78 through R81, R86, and R88 through R91 are not used. In position A (wiper 11 and cont 1), resistors R77 and R87 form the discrim ator output attenuator network.

b. Selector Switch S2. Selector switch S2 i nine position, two-section rotary switch wh permits the audio amplifiers and meter circu to be used in setting test-tone voltage lev The test-tone deviation from attenuator swi S1 or test-tone voltage levels, applied throu jacks J1 through J7, are selected by switch S and applied to audio amplifiers V5B and The output of audio amplifiers V5B and is coupled to the metering circuits by swi S2B.

202. Audio Amplifiers V5B and V6 (fig. 185)

a. Amplifier V5B. The input signal fr switch S2A (rear) is applied to the control g of V5B through limiting resistor R61 and veloped across grid resistor R60. Bias for V is furnished by cathode resistor R97 which bypassed by C30. A degenerative signal, gain stabilization, is applied to the grid fr a voltage divider in the plate circuit of au amplifier V6B (*c* below). The amplified sig output of V5B is developed across plate load sistor R62 and applied to amplifier V6A throu coupling capacitor C36. Resistor R63 and pacitor C31 form a plate-decoupling netwo

b. Audio Amplifier V6A. The amplified sig voltage output of V5B is applied to the cont grid of audio amplifier V6A and develop across grid resistor R72. Cathode resistor R and cathode bypass capacitor C37 furnish necessary bias for V6A. The amplified sig developed across plate load resistor R69 is plied to amplifier V6B through coupling pacitor C35. Resistor R67 and capacitor C form a decoupling network for the plate circu

c. Audio Amplifier V6B. The amplified sig voltage from V6A is applied to the grid of au amplifier V6B and developed across grid res tor R75. Bias for V6B is furnished by cath resistor R74 and cathode bypass capacitor C Parallel-connected potentiometers R70 and R are the plate load for V6B. A portion of output signal is selected by potentiometers R

d R71 and applied to the meter circuit ough selector switch S2B (rear) and pling capacitor C38. Potentiometer R71 is usted to give a SET POINT indication on ter M1 when a test-tone signal of a known iation (9 kc) is applied to jack J8. Potentieter R70 is adjusted to give a SET POINT ication on meter M1 when a test tone of a wn level (370 millivolts) is applied to jack In addition to the output being applied to meter circuit, it is also applied to the grid V5B through R64 from a voltage-dividing cuit consisting of capacitor C32 and resistors 5 and R66. This feedback provides stabilizan of the gain for the amplifiers. Resistor R68 d capacitor C34 form a plate-decoupling netrk.

3. Meter Circuit
(fig. 185)

The meter circuit consists of microampere ter M1 and bridge rectifier CR3, CR4, CR6, d CR7. The input signal voltage is rectified the bridge rectifier and applied to meter M1. rrent-limiting resistor R76 is series-conted with meter M1. Zener diode CR5 prots meter M1 against damaging voltages.

4. Monitor Power Supply
(fig. 185)

a. Input Circuit. When PWR switch S3 is at , 120-volt ac, single-phase, 400-cps power m terminals 1 and 2 of terminal board TB1 applied to terminals 1 and 3 of transformer through fuse F1. Red indicator lamp DS1 icates application of power to the transmer. Resistor R96 limits the current through mp DS1.

b. Filament Circuit. Secondary winding 8–9 transformer T1 reduces the 120-volt input tage to 6.3 volts ac. This voltage is applied to filament of tube V7. Secondary winding of -11 of transformer T1 provides the required -volt ac power for filaments of tubes V1 ough V6. Inductors L14 through L17 and pacitors C41 through C44 form RF depling circuits for the filament supply.

c. Rectifier and Filter Circuit. The high-voltage output of transformer T1 winding 5–7 is applied through series surge resistors R99 and R100 to a full-wave rectifier circuit consisting of diodes CR8 through CR11. Resistors R105 through R108 equalize the inverse voltage across the diodes. The rectified output is applied to a filter consisting of inductor L13 and capacitors C39 and C40. Resistors R93 and R94 equalize the voltage applied across each capacitor. The filtered dc output is applied to the regulator circuit.

d. Voltage Regulator Circuit. During normal operation, the grid of series regulator V7 is maintained at +205 volts by a voltage-divider network and by voltage regulators V8 and V9. The cathode of V7 is maintained at the B+ level (210 volts).

(1) Resistor R101 is series-connected with two 105-volt regulator tubes, V8 and V9, across the 290-volt output of the filter circuit. The voltage across the two regulators is stabilized at 210 volts. The grid of series regulator V7 is connected to the junction of voltage divider R102 and R103 and operates at a constant 205 volts with respect to ground. The difference between the grid voltage and the output voltage at the cathode of V7 is the bias on V7. The bias, controlled by the grid-to-ground voltage, is such as to provide an output voltage of 210 volts. The difference between the output voltage and the supply voltage (approximately 80 volts) is dropped across the dc plate resistance of V7. Resistor R92 stabilizes the regulating action of V7.

(2) When the output voltage at the cathode of V7 tends to decrease, the bias tends to decrease also. This condition results in a reduction in the dc plate resistance and a smaller voltage drop across the tube that almost offsets the decrease in output voltage. An increase in output voltage results in a converse action taking place. The net result is that a small variation in output voltage occurs when a much larger change occurs in the supply voltage.

CHAPTER 15

FUNCTIONING OF CIRCUIT BREAKER PANEL AND ANTENNA ORIENTATION METER

05. General

a. The circuit breaker panel accepts the ree-phase power input from the engine gen- ator (or from an auxiliary source) and dis- ibutes primary power to all equipment units the shelter. The panel contains a power urce selector switch, six circuit breakers, and small 28-volt dc power source.

b. The antenna orientation meter provides a sual indication of received signal strength. his meter is used by the operator to aid in igning the antenna.

06. POWER SOURCE SELECTOR Switch S1 (fig. 186)

POWER SOURCE SELECTOR switch S1 is three-section rotary switch used to transfer e shelter primary power input from the en- ne generator (GEN position) to an external xiliary power source (AUX position). Sec- on S1A switches phase C, section S1B vitches phase B, and section S1C switches ase A. MAIN BREAKER CB2 must be ened before operating the selector switch.

07. Circuit Breakers (fig. 186)

All ac power used in the shelter is connected rough relay-operated contractor CB1, which controlled by the spring-return LOAD CON- ROL switch on the engine generator instru- ent panel. Relay K3 of CB1 provides holding ntacts to hold it operated after the LOAD ONTROL switch is released. From contractor B1, the ac power is connected through MAIN REAKER CB2. Power is then distributed to rious circuits through ANTENNA circuit breaker CB3, AIR COND circuit breaker CB6, FLUSHING BLOWER circuit breaker CB8, RACK POWER circuit breaker CB7, and AUX OUTLET circuit breaker CB5. The ac power is also direct-connected from MAIN BREAKER CB2 to terminal boards TB–1A pin 10 and TB–1B pins 11 and 12 for use by the power amplifier cabinet. The power amplifier contains its own circuit breakers. The flushing blower is energized through relay-operated contactor K1 controlled by the FLUSHING BLOWER switch on the switch panel.

208. Power Supply, 28-Volt (fig. 186)

a. Phase A is direct-connected from switch S1C through fuse F1 to the primary of stepdown transformer T1. Bridge rectifier CR1, CR2, CR3, and CR4 is connected to the secondary of T1. The output of the bridge rectifier is series connected with Zener diode CR5, which limits the output voltage. The dc output is filtered by capacitor C1. Indicator DS1 is illuminated and relay K2 is energized at all times during operation from either the primary power or auxiliary power source. Prior to starting the engine generator, contacts A2 and A3 of relay K2 are closed, supplying 28 volts dc from the batteries to the engine control circuits. After the generator is started, thereby providing primary power, relay K2 energizes and contact A2 receives 28 volts dc from the power supply.

b. When an external auxiliary power source is selected, 28 volts dc is required to operate indicator and control circuits in the engine generator instrument panel (rack A2) even though the engine itself is not operating. Thus, if the 28-volt power supply fails (as evidenced by

nonillumination of indicator lamp DS1 on the circuit breaker panel), the AN/TRC–80 will not operate from an auxiliary power source.

209. Antenna Orientation Meter (fig. 28)

The antenna orientation meter, when used, is connected to jack J34 adjacent to the RCVR ANT waveguide connector (fig. 12, TM 11–5820–469–10). This connects the antenna orientation meter in parallel with the receive converter meter through the receive signal level monitor line (pin L of J4, fig. 53). The meter circuit consists of rc network A1 together with RESPONSE TIME potentiometer R1. Meter M1, connected in series with A1, provides an indication of the received signal strength.

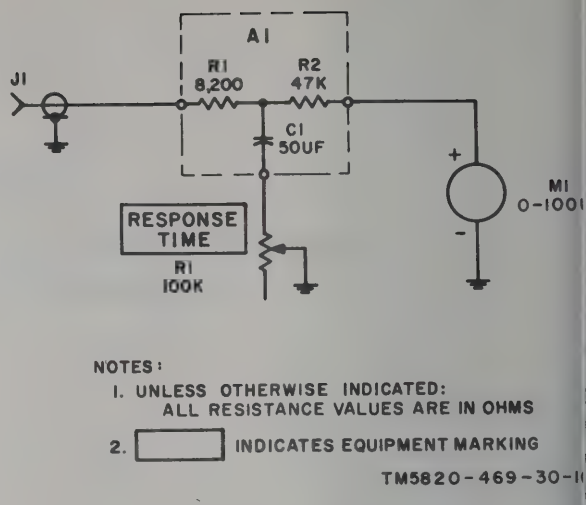


Figure 28. Antenna orientation meter, schematic diagram.

CHAPTER 16

GENERAL MAINTENANCE INFORMATION

Warning: **Operation of this equipment involves the use of extremely high voltages which are dangerous to life. Certain troubleshooting, alignment, and testing operations require energization of the equipment with cabinet doors or drawers open, exposing the high-voltage points. Whenever a door interlock, shorting switch, or other protective device is blocked or otherwise disabled, there is extreme danger to maintenance personnel. Do not disable the protective devices unless it is absolutely necessary; remove all disabling equipment, such as interlock blocks, immediately after the maintenance is complete. *Do not leave the equipment location while protective devices are disabled.*** **Always ground circuits before touching them. Voltages in excess of 7,500 exist in the klystron drawer; voltages in excess of 1,600 are present in the transmit inverter. Do *not* service alone. Do *not* depend on door locks and grounding switches for protection. Turn the equipment power off whenever it is not absolutely necessary to operate the equipment while making measurements or tests. Be particularly careful when hands and arms are damp with perspiration. Body salts conduct electricity.**

210. General

a. The direct support maintenance procedures in this manual *supplement* the procedures described in the organizational maintenance manual (TM 11–5820–469–20). The systematic troubleshooting procedures, which begin with the operational, sectionalization, and localization checks that can be performed at an organizational level, are carried to a higher level in this manual. When an abnormal symptom indicates that a certain major unit is defective, refer to the functional chapter covering that unit. A thorough knowledge of the circuit functions and the system checks performed by the monitor (para. 20, TM 11–5820–469–20), and observation of the meter indications described in the organizational, sectionalization, and localization procedures will aid in determining which component is defective.

b. Rack and interrack coaxial cabling information is provided in figure 39 of TM 11–5820–469–20. Complete schematic and block diagrams and the equipment wiring diagram (fig. 189) are located at the back of this manual.

c. Data on fuse values and fuse location is covered in TM 11–5820–469–10 (para. 83).

d. A thorough visual check of the equipment should be given when trouble occurs. Check for loose wires and disconnected cables. Be sure that the tubes are all firmly in place. Look for charred insulation and for components which appear to be overheated.

211. Troubleshooting Procedures

a. General. The first step in troubleshooting a defective AN/TRC–80 is to sectionalize the fault. Since this equipment may be classified into four major equipment areas (primary power equipment, frequency generating and transmission equipment, receiving equipment, and antenna system), sectionalization of troubles is confined to sectionalizing the defect to a unit (IF amplifier, receive converter, etc.) within an equipment grouping. Normally, all sectionalization procedures will be performed on units while they are installed within the AN/TRC–80 shelter. The second step in troubleshooting is to localize the fault. Localization in the AN/TRC–80 refers to localizing troubles to a subassembly or module. When the trouble within a subassembly or module is confined to a defec-

tive pluckout item, the repair may be effected without removing the module from the shelter. However, module or subassembly repair is generally performed in the maintenance van or shop because of the space limitations within the shelter area.

b. Sectionalization. The sectionalization procedures in TM 11–5820–469–20 (paras. 13 through 19) are adequate for sectionalizing a defect to a unit within a major equipment group. Always use the troubleshooting procedures in the organizational maintenance manual in conjunction with the procedures in this manual when troubleshooting the AN/TRC–80.

c. Localization. Localization procedures in the organizational maintenance manual are confined to localizing trouble to a pluckout item. The localization procedures in this manual begin where the localizing procedures in the organizational maintenance manual end. When localizing troubles in the AN/TRC–80, refer to paragraphs 21 through 33 in TM 11–5820–469–20 and locate the troubleshooting chart that pertains to the unit that has been sectionalized as being defective. Perform the recommended checks and corrective actions. When the corrective measures do not restore normal operation, or if no corrective measures are listed, refer to the appropriate troubleshooting procedures in this manual.

d. Isolation. During the detailed process of fault isolation, the failure can usually be traced by testing tubes or transistors, performing voltage and resistance measurements, substituting easily replaced sections, and by referring to schematic diagrams and making lead continuity measurements with Multimeter TS–352A/U (or an equivalent multimeter). Vacuum tube voltmeters such as the ME–26B/U and ME–30B/U are preferred for level measurements. Most voltage and resistance measurements can be taken by removing the tube, inserting a tube socket adapter, and inserting the tube into the adapter. The accuracy of most measurements made in this manner will not be significantly altered by the insertion of the adapter. However, high-impedance rf circuits may be detuned by the added lead length and, in rare cases, a previously stable circuit may begin to oscillate or pick up hum. When in doub remove the backplate and make measur ments directly at the tube socket.

***Warning:* Be extremely careful of high vol ages that are exposed when the backplate is r moved.**

212. Equipment Repair

a. Removal and Replacement. In most case it will be necessary to remove a chassis fro the rack for extensive troubleshooting or fo parts replacement. Removal and replacemer procedures that are not obvious are detailed i paragraphs 277 through 290. Certain screws o some modules are secured with a liquid lock ing compound. It is strongly recommended tha these screws, once removed, be discarded an new screws reinstalled with a fresh coat o locking compound.

b. Parts Replacement. Component replac ment should be performed carefully to avoid in troducing new troubles into the equipmen Follow a systematic procedure; know wher each lead goes. Use identification tags or mark ers when a number of lead wires are involve When components are replaced in high-fr quency circuits, *always* maintain the sam physical parts arrangement. Use the origina ground points and cut leads to equal the lengt of those on the original component. This wi prevent detuning and eliminate the possibilit of introducing spurious oscillations.

c. Use of Test Equipment. When making a voltage measurements with vacuum tube volt meters such as the ME–30B/U, the repairma should be alert to the possibility of encounter ing undesirable hum fields when measurement are made directly within the shelter. Attach th ground lead to the chassis being tested and at tach the hot lead of the voltmeter to a chassi point near the location of the desired measur ment point. Verify that the meter gives a zer indication on the meter scale chosen. It may b necessary in extreme cases to abandon the at tempt to make in-shelter ac voltage measur ments. This difficulty will seldom occur whe making dc measurements. The chapters whic follow normally call for the unit under test t

be removed from the shelter and replaced with a spare.

213. Transistor Circuits

Special precautions must be observed when troubleshooting and repairing transistor circuits. Physical characteristics of transistors or other solid state electronic devices make them sensitive to ac and dc voltages and currents, and to heat that may be applied by soldering irons. Observe the general precautions listed below:

a. Test Equipment.

(1) All test equipment must be powered with transformer-type power supplies.

(2) Ground connections must exist between the test equipment and the unit under test before connecting the meter lead to the point to be measured.

(3) High sensitivity multimeters (minimum sensitivity of 5,000 ohms per volt) can be used for many measurements, but the use of a regular vacuum tube voltmeter is preferred.

(4) Ohmmeter current must never exceed 1 milliampere in any range. When making resistance measurements, follow the directions given in the notes on the illustrations. When testing diodes, the same precautions apply. *Note that the lead polarity and meter range selected can materially influence the readings.*

b. Soldering.

(1) Soldering irons used should not exceed 35-watt rating.

(2) Use an isolation transformer when possible.

(3) When possible, disconnect the soldering iron from the powerline when performing the actual soldering operation. If this is not possible, connect a ground wire between the equipment chassis and the metal tip of iron.

(4) Use a heat sink between the point of soldering and the semiconductor component. Medium or large-sized alligator clips are useful for this purpose. The lead can also be held with a pair of long-nose pliers to absorb the excess heat which would otherwise reach the semiconductor materials.

c. Transistor Testing.

(1) Use a transistor test set if possible.

(2) If necessary, an ohmmeter satisfying the conditions listed in *a*(4) above may be used.

(3) An ohmmeter indication for a forward-biased junction should indicate 500 ohms or less. A reverse-biased junction should indicate 50,000 ohms or more.

(4) *Never short the leads of a transistor in an operating circuit.* Under certain conditions, this can destroy the transistor.

(5) *Never remove or replace a transistor while voltage is applied to the circuit.*

214. Test Equipment and Tools

a. The chart below lists the test equipment and tools required.

Test equipment	Technical manual	Common name
Signal Generator AN/URM–48	TM 11–1257	Fm signal generator.
Signal Generator SG–71/FCC	TM 11–5088	Audio signal generator.
Electron Tube Test Set TV–7/U	TM 11–6625–274–12	Tube tester.
Radio Frequency Power Test Set AN/USM–96A (must include thermistor detector).	TM 11–6625–248–12	RF power meter.
Multimeter ME–26B/U	TM 11–6625–200–12	Electronic multimeter.
Electronic Voltmeter ME–30B/U	TM 11–6625–320–12	Voltmeter.
Multimeter TS–352/U	TM 11–5527	Multimeter.
Modulation Meter ME–57/U	TM 11–6625–400–12	Modulation meter.
Signal Generator AN/GRM–50 (or equivalent).	TM 11–6625–573–15	RF generator.

b. The tools required for maintenance are included in Radio Repair Tool Kit TK–115/G and Radar and Radio Repairman Tool Kit TK–87/U.

215. Test Facilities Kit (fig. 150)

The test facilities kit used with the AN/TRC–80 is contained within three portable carrying cases. One case contains the miscellaneous test and extender cables, together with a variety of coaxial attenuators and cable adapters. Another case contains six individual test sets that are used during troubleshooting and alignment procedures. The third case contains a special blower that is connected to the receive or transmit converter when it is removed from the rack and associated rack blower. Subparagraphs *a*, *b*, and *c* below describe the contents of the test facilities kit.

a. Extender Cables and Adapters. The items contained within the extender cables and adapters case are described below and are illustrated in figure 150 (items 1 through 33). Directions for their use are provided in the applicable troubleshooting or alignment procedures.

Item No.	Description
1	Attenuator, Coaxial Type N, 10db
2	Resistive termination, BNC, 52.5 ohms
3	Attenuator, Coaxial Type N, 20db
4	Attenuator, SHF Coaixal Type TNC, 10db
5	Attenuator, SHF Coaxial Type N, 20db
6	Adapter, TNC right angle (2)
7	Adapter, BNC female to TNC male
8	Adapter, BNC tee, female-male-female (2)
9	Adapter, N female to TNC male
10	Adapter N female to TNC female
11	Adapter, N male to BNC female
12	Adapter, BNC female to GR male (4)
13	Adapter, N female to N female
14	Adapter, N female to BNC male
15	Quartz crystal, channel 595, (30.07500 mc)
16	Quartz crystal, channel 762, (32.16250 mc)
17	Quartz crystal, channel 927, (34.22500 mc)
18	Test cable, BNC-alligator clips (2)
19	Test cable, BNC-BNC (2)
20	Resistive termination, BNC, 287 ohms
21	Resistive termination, BNC, 619 ohms
22	Extender cable, IF module (2)
23	Test cable, GR-alligator and pin
24	Power cord, spade lugs (2)
25	Test cable, extender, coaxial, IF modules (6)
26	Test cable, extender, pa control panel drawe
27	Test cable, extender, 70-mc RF preamplifie and tuneup oscillator
28	Test cable, extender, oscillator unit and multi plier unit
29	Test cable, extender, modulator-multimete order-wire input
30	Receiver system test cable
31	Multiplexer test cable and termination adapte
32	Special adapter A (2)
33	Special adapter B (2)

b. Test Sets (fig. 150). Six test sets ar mounted on one panel within a portable carry ing case. All test set circuits receive primar power (115 volts, 60 cps) from one commo power plug that is permanently attached to th carrying case. The chassis connection cables as sociated with each test set are also permanentl attached to the front panel. Detailed instruc tions for using all the test sets are provided i the applicable troubleshooting or alignmen procedures in this manual. The function of th test sets is described in (1) through (6) below

(1) *Teletypewriter test set.* The teletype writer test set is used with the tele typewriter switch panel of the AN TRC–80. The cable on the test pane mates with the connector on the tt switch panel. An audio oscillator sup plies the test signal through an isolat ing resistor. The LINE SIMULATOF SELECTOR switch permits loadin the two-wire terminals to simulate short, medium, long, or open tty line Switching and continuity measure ments are made between the variou jacks on the test panel.

(2) *IF power supply test set.* This test se supplies a high wattage resistive loa for each of the three self-containe power supplies (A1, A2, and A3) i the IF amplifier of the AN/TRC–80 Test points are provided for con venient access to these voltages Loads are also provided for the a and dc filament voltages within the I power supplies.

(3) *Power amplifier alarm and overload test set.* This test set supplies an adjustable dc voltage to permit setting the three power amplifier alarm level controls. A switch (NORMAL-OVERLOAD TEST) simulates a momentary overload condition in the klystron power supply. If the overload is momentary, the control relays in the control panel of the pa in the AN/TRC–80 should recycle and resume normal operation. Controls are provided to adjust the incident and reflected voltages and a 1.5-volt source is used in conjunction with the agc level adjustment.

(4) *Converter power supply test set.* This panel supplies a resistive load for the power supply module in the receive converter power supply chassis. In addition, a 1.5-volt source is provided to energize the agc chopper-amplifier input. The agc input level is adjustable and test points are provided for monitoring purposes.

(5) *Regulated 200-volt power supply test set.* This test set permits testing of the 200-volt self-contained power supplies used in various chassis of the AN/TRC–80. Controls are provided for testing the power supplies under full load, half load, and no load conditions. Test points are provided for voltage measurement of the 200-volt power supply output.

(6) *Traveling wave tube power supply test set.* This test set simulates both the filament and high-voltage load during normal operation. Two 10:1 voltage dividers, with appropriate test points, are provided to permit measurement of helix and collector potentials. Test points are also provided to permit measurements of the ac ripple in the cathode circuit and measurement of the filament voltage.

c. Blower Kit. The blower kit is contained in a portable carrying case that also houses a special test cover (backplate) for the transmit converter being serviced and two flexible airhoses. The normal backplate on the converter is removed to permit access for service. The special backplate is substituted, and hose connections are made to supply air for the traveling wave tube while the unit is being operated on the bench. A second hose permits supplying air to one other chassis at the same time. Airhose connection instructions are provided in the applicable troubleshooting or alignment procedures.

CHAPTER 17

TRANSMIT GROUP TROUBLESHOOTING

Section I. LOCALIZING TROUBLES

216. Localizing Procedures

The transmit group consists of Modulator-Multiplier MD–465/TRC–80, Amplifier-Converter AM–3303/TRC–80, and Radio Frequency Amplifier AM–3308/TRC–80. When a defect in the transmit group is suspected (low or no output power from the power amplifier), the following checks will help to determine which major unit (power amplifier, transmit converter, or modulator-multiplier) within the transmit group is defective. Before performing any of the checks listed below, check the interunit input and output coaxial cable connectors. Refer to the organizational maintenance manual (TM 11–5820–469–20) for illustrations showing the location of jacks and terminal boards and the coaxial cable diagram.

a. Initial Procedure. When the trouble symptom is not known, or if the power output is below normal, refer to paragraph 66 of TM 11–5820–469–10 and perform the transmitter tuning procedure. By performing the transmitter tuning procedure, a defect can usually be sectionalized to a specific major unit.

b. Troubleshooting Data. When the equipment will not tune up correctly, refer to the troubleshooting procedures in the organizational maintenance manual (paras. 13 through 19, TM 11–5820–469–20). Perform the recommended corrective measures. If the recommended procedures do not restore normal operation, check to see that a signal is being applied from the modulator-multiplier to the transmit converter and that the power amplifier is being driven correctly by the transmit converter by performing the procedures listed in paragraphs 217, 218, and 219.

217. Modulator-Multiplier Localizing Procedure
(fig. 67)

The following in-shelter checks will determine the operating condition of the modulator-multiplier. If the indications listed below are not obtained, the modulator-multiplier is probably defective. Refer to paragraph 232 for troubleshooting procedures.

a. Check for 200-volt dc test jack J11.

b. Set the meter function selector switch (on the transmit converter) to J. OUTPUT. The normal meter indication should be 60.

c. Depress CARRIER SWITCH S2. The meter indication should drop to zero. This switch disables the 70-mc output of the modulator-multiplier and therefore should also disable the output of balanced modulator A6 in the transmit converter. If it does not, tunable filter A5 on the transmit converter probably has been accidentally tuned to select the local oscillator or carrier signal output of the varactor multiplier instead of the upper sideband mixer product (sum of 70-mc modulator-multiplier output and varactor multiplier output carrier signal). Recheck tuning of filter A5 (12, para. 218*b*) to insure selection of the *first* response 70 mc *higher* than the varactor multiplier signal. It is possible to excite the klystron directly with the varactor multiplier carrier signal, but this incorrect procedure makes it impossible to modulate the transmitter and places the carrier on the wrong frequency.

d. Unscrew the four right-hand screws which secure this chassis to rack A1 and swing the unit out. Remove connector P1 (cable 31W52)

from chassis connector J6 (fig. 24, TM 11–469–20) and terminate this jack with a 50-ohm noninductive load, using a BNC tee-adapter (8, fig. 150). Use an ME–26B/U to measure approximately 2.0 to 3.0 volts ac at the open end of this adapter. If the desired reading is not obtained or if modulation trouble is suspected, refer to paragraph 235.

218. Transmit Converter Localizing Procedures (fig. 46)

The tuning meter on the meter panel of the transmit converter provides a means of trouble localization. When troubleshooting procedures at the organizational maintenance level (paras. 17 and 28, TM 11–5820–469–20), do not restore normal operation; perform the following checks before removing the transmit converter for d tailed troubleshooting.

a. Preliminary. Refer to paragraph 66*a* TM 11–5820–469–10, and very carefully retu the transmit converter. The transmit convert will *not* tune correctly unless the frequen synthesizer input is normal. If the frequen synthesizer input is suspected, temporarily su stitute snythesizers by interchanging the outp cables at J604 (fig. 27, TM 11–5820–469–20).

b. Trouble Localizing Chart. If substitutin the synthesizer input has no effect upon tran mit converter tuning, perform the localizin procedures listed below to localize the defe to one of the units (oscillator, multiplier, vara tor multiplier, etc.) within the transmit co verter:

Note. Refer to figure 52 (TM 11–5820–469–10) f location of all adjustment controls specified in t *Procedure* Column of this chart.

Step	Meter function selector switch setting	Procedure	Normal meter indication	Corrective measures
		Note. The crystal oscillator in the oscillator module is used only when the AN/TRC–80 is not part of the Pershing Weapons System. When the AN/TRC–80 is part of the Pershing Weapons System, set S1 to EXT and omit steps 1 and 2.		
1	A	Place S1 in the INT position. Tune C1 on the oscillator module for a maximum meter indication.	45	Check Y1, V1 (para. 226
2	NULL A	Tune C1 for the best possible null.	10	Same as above.
3	B	See that S1 is set to EXT. Tune C2, C3, and C4 on the oscillator module for a maximum meter indicator. Adjust R32 for midscale indication (50). The position of this control affects all the following adjustments.	50	Check stages V2, V3, a V4 in the oscillator mo ule (para. 226).
4	C	Tune C3 and C6 on the multiplier unit for a maximum meter indication.	75	Check stage V1 in mult plier unit (para. 227).
5	D	Tune C14 on the multiplier unit for a maximum meter indication.	82	Check stage V2 in mult plier unit (para, 227).
6	E	Tune C22 on the multiplier unit for a maximum meter indication.	100	Check stage V3 in mult plier unit (para. 227).
7	F	Tune the large cavity end knob F on the multiplier unit for maximum meter indication.	80	Check V4 (para. 227).
8	G	Tune the small cavity end knob G on the varactor multiplier for maximum meter indication.	90	Check varactor multipli assembly A3 (para. 228
9	H	Tune the large cavity end knob H for maximum meter indication.	72	Check varactor multipli assembly A3, RF cryst detector CR4 (para. 228).

tep	Meter function selector switch setting	Procedure	Normal indication meter	Corrective measures
0	HELIX	No adjustment during normal tuning.	9	Check V1 through V8 in traveling wave tube power supply and traveling wave tube V9 (para. 230).
1	COLLECTOR	No adjustment	48	Same as above.
2	J. OUTPUT	Adjust tunable filter A5 to select the proper mixer product. Locate the varactor multiplier output signal. It will *not* disappear when the modulator-multiplier CARRIER test switch is depressed. Tune filter 70 mc higher to the next response. This mixer product *will* disappear when the CARRIER switch is depressed.	60	Check balanced modulator A6, tunable filter A5, RF crystal detector CR5 (para. 229).

19. Power Amplifier Cabinet Localizing Procedures

Warning: **Extremely high voltages exist in he power amplifier assembly. In the power amlifier drawer, an adjustable negative potential rom 5,900 to 7,700 volts exists between the lystron filaments and ground. Spring-loaded horting bar S301 (fig. 41) grounds the dc outut whenever the drawer is removed from the abinet. *Do n ot disable S301 unless it is absoutely necessary.* If S301 is disabled during naintenance, be absolutely certain that the proective action of S301 is restored immediately fter maintenance is completed. *Do not leave he equipment location while S301 is disabled.***

DO NOT PERFORM ANY VOLTAGE MEASUREMENTS ON THE KLYSTRON OR POWER SUPPLY DRAWERS UNLESS SPECIFICALLY DIRECTED.

a. General. The various meters, indicators, and alarms on the front panel of the power amplifier cabinet provide a rapid means of trouble localization. The function of the various indicators is described in paragraph 46 of TM 11–5820–469–10. When tuning procedures (or front panel indicators) indicate that a defect exists within the power amplifier cabinet, refer to the power amplifier troubleshooting chart in the organizational maintenance manual (para. 29, TM 11–5820–469–20). If the checks and recommended actions at the organizational level do not restore normal operation, check the symptoms listed in the trouble localization chart (*b* below) to localize the trouble to one of the drawers (klystron, power supply, or control panel) within the power amplifier cabinet.

b. Power Amplifier Cabinet Trouble Localization Chart.

Note. If the control panel drawer is defective in any way, it is generally not possible to analyze indications in he remaining two drawers.

Symptom	Trouble localizing procedure
eam voltage does not come on (or fails to remain on) when BEAM ON switch S103 is momentarily depressed.	*a.* Turn off BEAM circuit breaker CB302 on the power supply drawer. Depress the BEAM ON switch. BEAM indicator DS105 should light, but the BEAM VOLTAGE meter indication will be zero. If the BEAM indicator does not remain lighted, a defect exists in the control panel drawer or the alarm circuits which prevent the relays from holding (para. 221).

Symptom	Trouble localizing procedure
	b. Place the MAIN circuit breaker in the OFF position an pull out (do not remove completely) the power suppl drawer. Carefully unscrew klystron filament conne tors P301 and P302 from J301 and J302 (fig. 41 Wrap the loose connectors in an insulating materi to prevent them from shorting to each other or an other point. Position the connectors so that the powe supply drawer can be closed without interference.
	c. Turn on the MAIN and BEAM circuit breakers an wait for the TIME DELAY indicator to come o The filament voltage control must be adjusted no mally even though the klystron filaments are n connected (this action activates 3-minute time dela relay K105). Depress the BEAM ON switch. Th BEAM indicator will illuminate the BEAM VOLT AGE meter should indicate approximately 6.6 kil volts. The BEAM CURRENT meter will indicat zero (because the filaments (cathode) have been di connected). If the BEAM circuit breaker trips imm diately, or if there is no BEAM VOLTAGE mete indication, the power supply drawer is defectiv (para. 222).
	d. If the BEAM VOLTAGE indication is normal (indica ing normal power supply operation), the defect pro ably exists in the klystron drawer (para. 223).
Low input drive signal. (POWER IN meter M101, with selector switch S104 set to INCIDENT, indicates less than 30 milliwatts.)	*a.* Adjust DRIVE LEVEL attenuator AT201 (fig. 5 TM 11–5820–469–10) in the klystron drawer (par 292).
	b. Adjust LEVEL ADJUST control R32 (fig. 52, TM 11 5820–469–10) on the transmit converter chassis (par 218*b*).
	c. If input level cannot be adjusted above 30 milliwatt refer to the transmit converter troubleshooting cha (para. 224).
BEAM VOLTAGE and BEAM CURRENT meter indications not at midscale. (Exact indications depend upon position of BEAM VOLTAGE selector switch S302 and the particular klystron installed.)	*a.* If BEAM VOLTAGE selector switch S302 does not re store normal meter indications, trouble probably exist in the power supply drawer (para. 222).
	b. Check klystron adjustment (para. 292).
Caution: **The beam voltage should never be allowed to exceed 8,000 volts and the beam current should not exceed 510 milliamperes.**	
BEAM indicator does not light when BEAM ON pushbutton switch is depressed (or remain on when the pushbutton is released).	*a.* Check the high-voltage relay control circuits in the con trol panel drawer (para. 221).
	b. Current overload exists in the power supply drawe (para. 222).
TIME DELAY indicator DS102 does not light.	Defect in control panel drawer (para. 221), or filamen voltage control not set properly.
No BEAM VOLTAGE indication.	See that beam circuit breaker CB302 has not tripped du to an overload. IF CB302 has tripped, a defect ma exist in the control panel drawer (para. 221) or th power supply drawer (para. 222).
DRAWER indicator DS103 not lighted.	See that both the control panel drawer and the powe supply drawer are properly positioned and locke (High-voltage interlock switch S201 (fig. 44) is actu ated when the right-hand drawer lock handle is no properly secured.)

Symptom	Trouble localizing procedure
AIR indicator DS104 not lighted. (This indicator is actuated by air interlock S201 and thermal interlock S202 in the klystron drawer.)	See that BLOWER circuit breaker CB303 has been closed. See that both the air intake and exhaust doors on the shelter have been opened. Check air filters for dust, ice, or other obstructions (para. 12, TM 11–5820–469–20). If AIR indicator remains off, refer to control panel drawer troubleshooting procedures (para. 221). *Note.* Air interlock switch S201 prevents the application of beam voltage if airflow is restricted. Thermal interlock switch S202 (in series with S201) opens when the klystron tube overheats.
Drive level correct (30 to 50 milliwatts), but power output low.	Increase the position of BEAM VOLTAGE tap switch S302. (Some klystrons may require more beam voltage and current for a given power output.) If position 5 or 6 of switch S302 does not provide rated output power, refer to the klystron drawer troubleshooting procedures (para. 223).

Section II. TROUBLESHOOTING POWER AMPLIFIER

Warning: **Extremely high voltages exist in the power amplifier assembly. In the power amplifier drawer, an adjustable negative potential from 5,900 to 7,700 volts exists between the klystron filaments and ground. Spring-loaded shorting bar S301 (fig. 41) grounds the dc output whenever the drawer is removed from the cabinet. *Do not disable S301 unless it is absolutely necessary.* If S301 is disabled during maintenance, be absolutely certain that the protective action of S301 is restored after maintenance is completed. *Do not leave the equipment location while S301 is disabled.***

220. General

Maintenance on the klystron drawer is normally performed within the shelter itself. All klystron power tests must be made with the klystron tube installed normally. Since the power supply drawer requires 400-cps power, it is most easily tested as part of the complete cabinet assembly. The control panel drawer, however, should be removed for adjustment, troubleshooting, and repair procedures. It must be replaced in proper operating condition before the remainder of the power amplifier can be tested. The location of the cabinet jacks and miscellaneous cabinet hardware is illustrated in figure 29, parts 1 and 2. The complete schematic and interdrawer connections are illustrated in figure 159.

221. Control Panel Drawer Troubleshooting

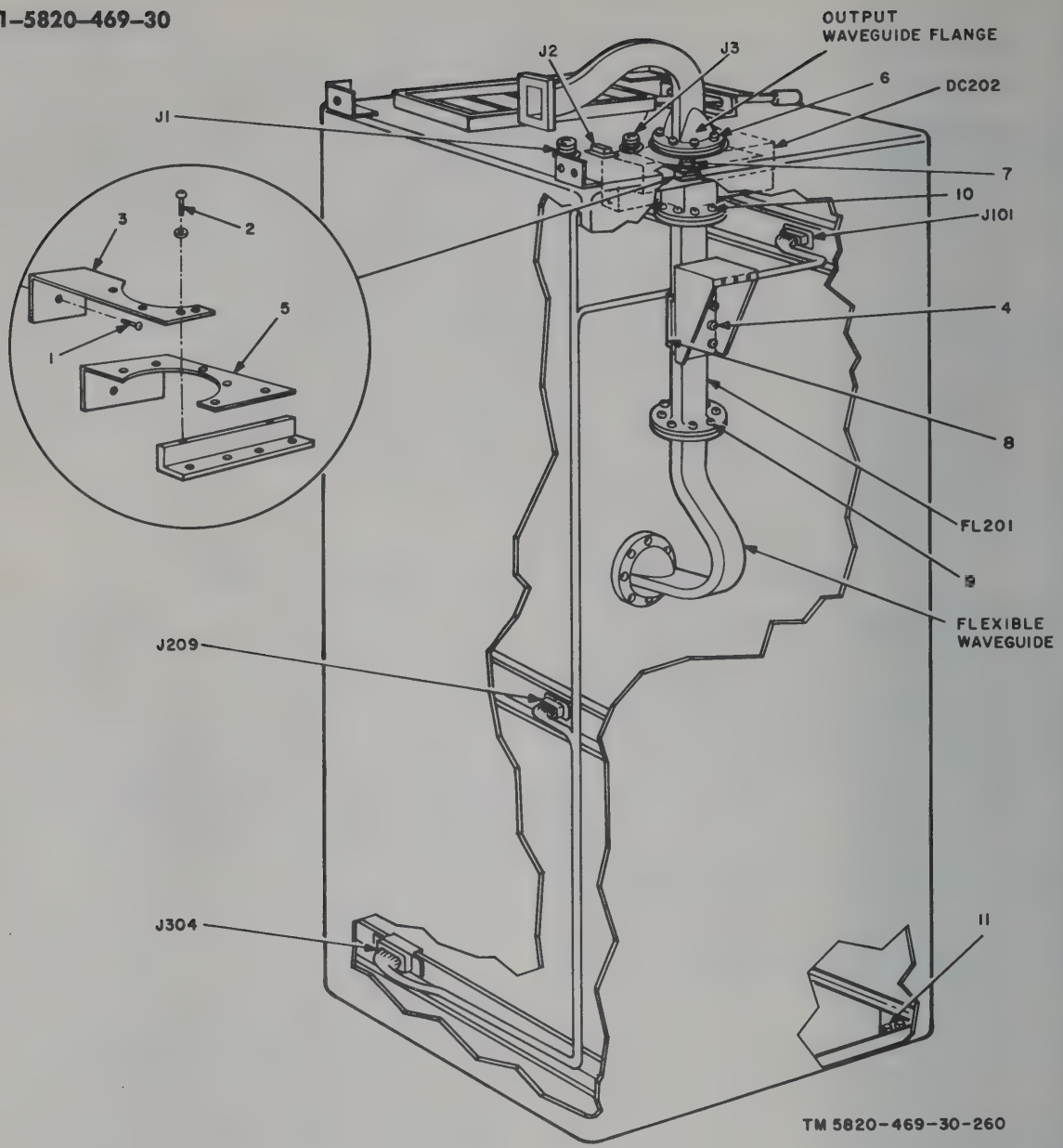
Note. Component locations for the control panel drawer are illustrated in figures 31 through 39.

a. Test Connections. Space limitations within the shelter prohibit extensive troubleshooting of the control panel drawer within the shelter. Minor repairs may be performed by using the control panel drawer test cable extender (26, fig. 150) connected between J101 on the pa cabinet (fig. 29) and P101 on the rear panel of the control panel drawer. Major repairs must be performed in the maintenance van. To perform the procedures given in this paragraph, remove the control panel drawer from the cabinet (para. 43, TM 11–5820–469–20) and connect P101 to the mating jack on the extender cable of the pa alarm and overload test set (fig. 150). To apply power to the test set and the control panel drawer, insert the test set power plug into a 115-volt ac source and turn the POWER switch on the test set to ON.

b. Test Procedures.

(1) Inaccurate or erratic front panel meter indications on the control panel will be obtained if the control, alarm circuits, or the chopper balance circuits are out of adjustment. Refer to paragraph 291 for adjustment procedures.

(2) If trouble is suspected in the amplifier stages, refer to figure 30 and perform



1 Rear coupler support bracket retaining screw
2 Rear coupler support bracket retaining screw
3 Rear coupler support bracket
4 Mounting screws (mount FL201 to bracket)
5 Flange bracket
6 Output waveguide flange retaining screws
7 Access hole
8 Filter FL201 support bracket
9 Retaining screws (secures bottom of FL201 to flexible waveguide)
10 Retaining screws (secure top of FL201 to DC202)
11 Base securing bolts

Figure 29. Power amplifier, location of cabinet-mounted components (part 1 of 2).

voltage and resistance measurements. Refer to figure 159 for the complete schematic diagram. Use the ME–30B/U for all ac measurements.

(3) During normal operation, K101 and K102 are energized, and direct alarm relay K103 is deenergized. Use Multimeter TS–352A/U for relay coil continuity measurements.

(4) The function of the operational sequence of the relays, in the control panel drawer is covered in paragraph

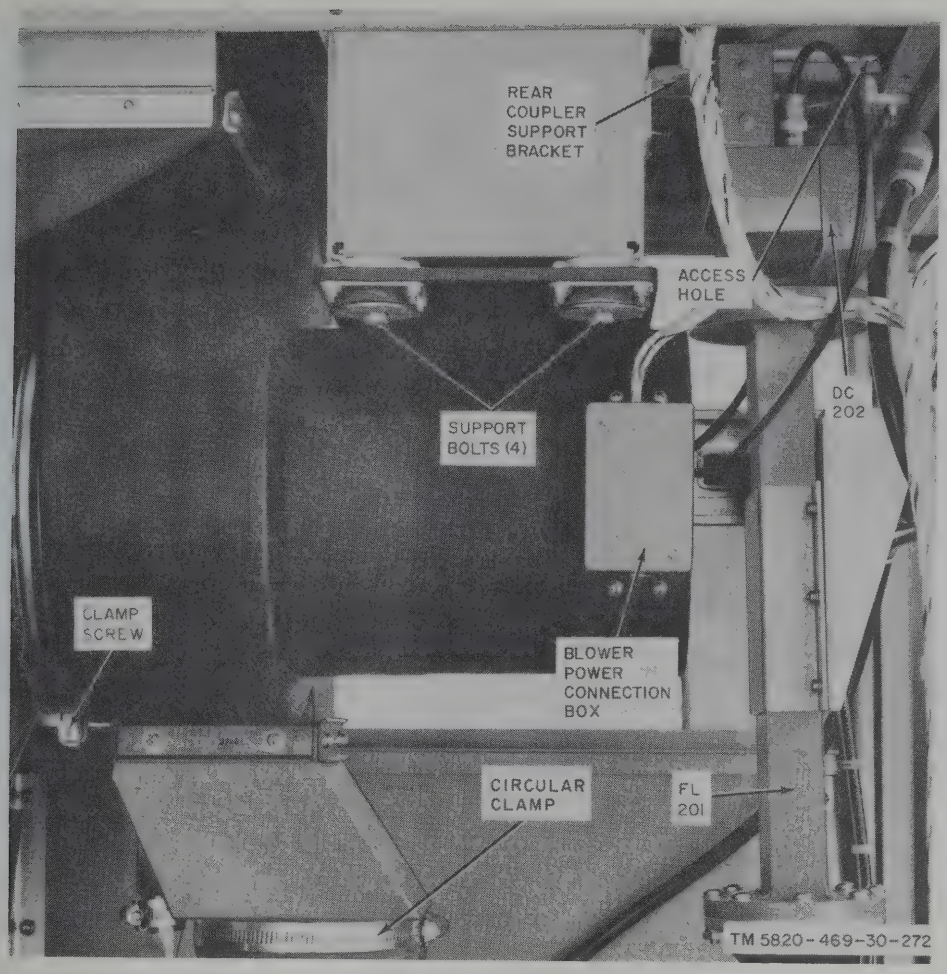


Figure 29. Power amplifier, location of cabinet-mounted components (part 2 of 2).

68 through 73. The function of relays and relay amplifiers is covered in paragraphs 74 through 83.

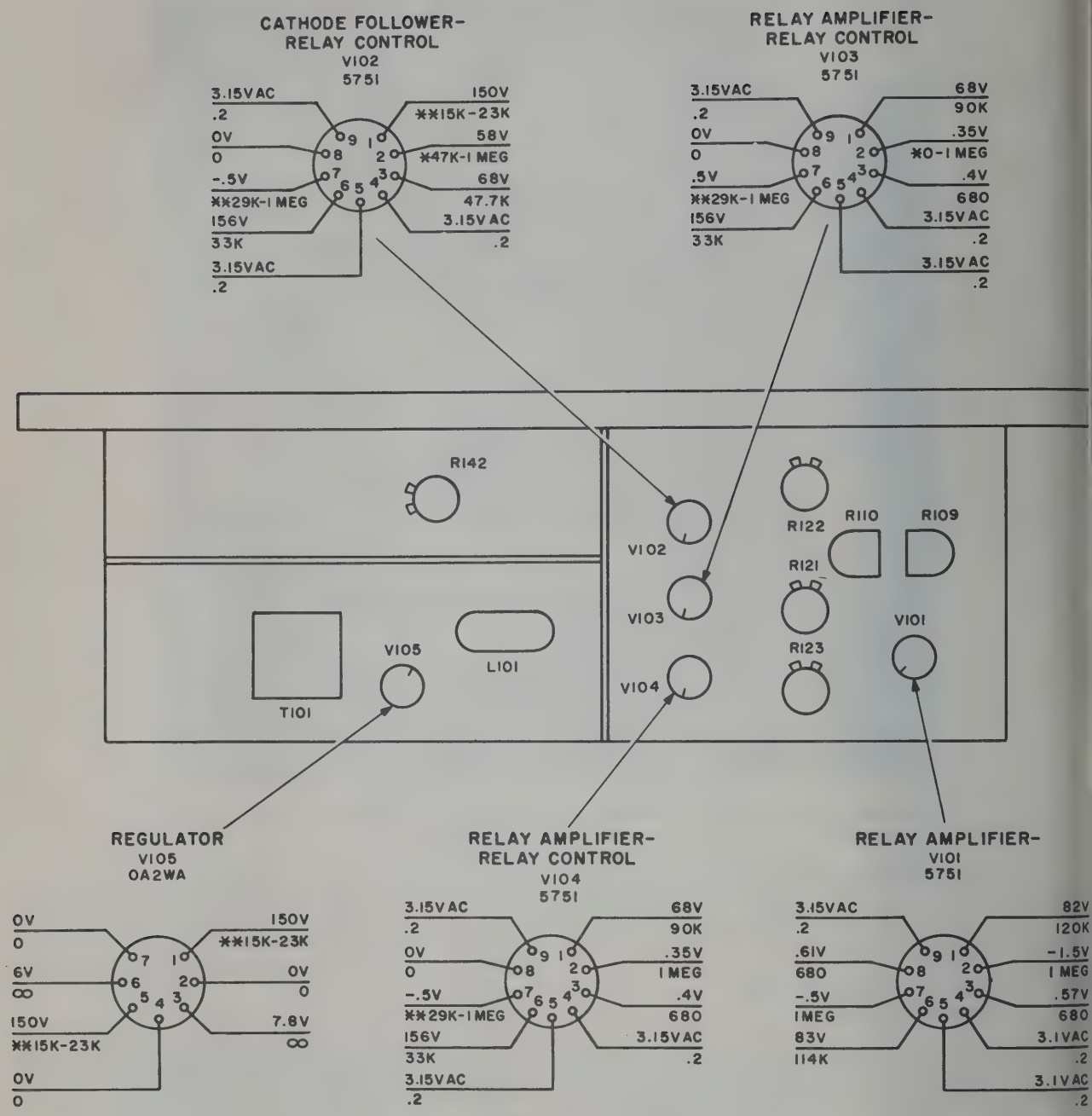
222. Pa Power Supply Drawer Troubleshooting

Note. Figures 40 through 43 illustrate component locations in the power supply drawer. Figure 159 is the complete schematic diagram. Detailed functions of the power supply drawer are covered in paragraphs 66 and 67.

When the troubleshooting procedures given in the organizational manual (TM 11–5820–469–20) or localizing procedures given in paragraph 219 indicate a defective power supply drawer, perform the following procedures:

Warning: **Voltages in excess of 7,000 volts exist in this power supply drawer when the power is on.** ***Instant death may result on contact*** **with any of the bridge rectifier components (T301, C303 through C309, CR303 through CR308, etc.) Do not perform voltage measurements.**

a. The power supply drawer contains no tubes or transistors. Troubleshooting this drawer consists primarily of using a multimeter for continuity measurements. Most troubles within the power supply drawer will be the result of an overload or short-circuit condition. This will be the case if MAIN circuit breaker CB301, BEAM circuit breaker CB302, beam relay contractor K302, or klystron overload relay K303 operates to disable the power supply when the BEAM ON pushbutton is pressed.



NOTES:

1. VOLTAGE MEASUREMENTS TAKEN WITH VTVM
2. RESISTANCE MEASUREMENTS TAKEN WITH 20,000 OHM-PER-VOLT METER
3. ALL MEASUREMENTS USE GROUND REFERENCE
4. RESISTANCE MEASUREMENTS TAKEN WITH POWER REMOVED

* VALUE MAY DIFFER ACCORDING TO SETTING OF POTENTIOMETER
** VALUE WILL BE DETERMINED BY METER POLARITY AND WILL BE ONE OF TWO VALUES

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Figure 30. Power amplifier control panel drawer, voltage and resistance measurements.

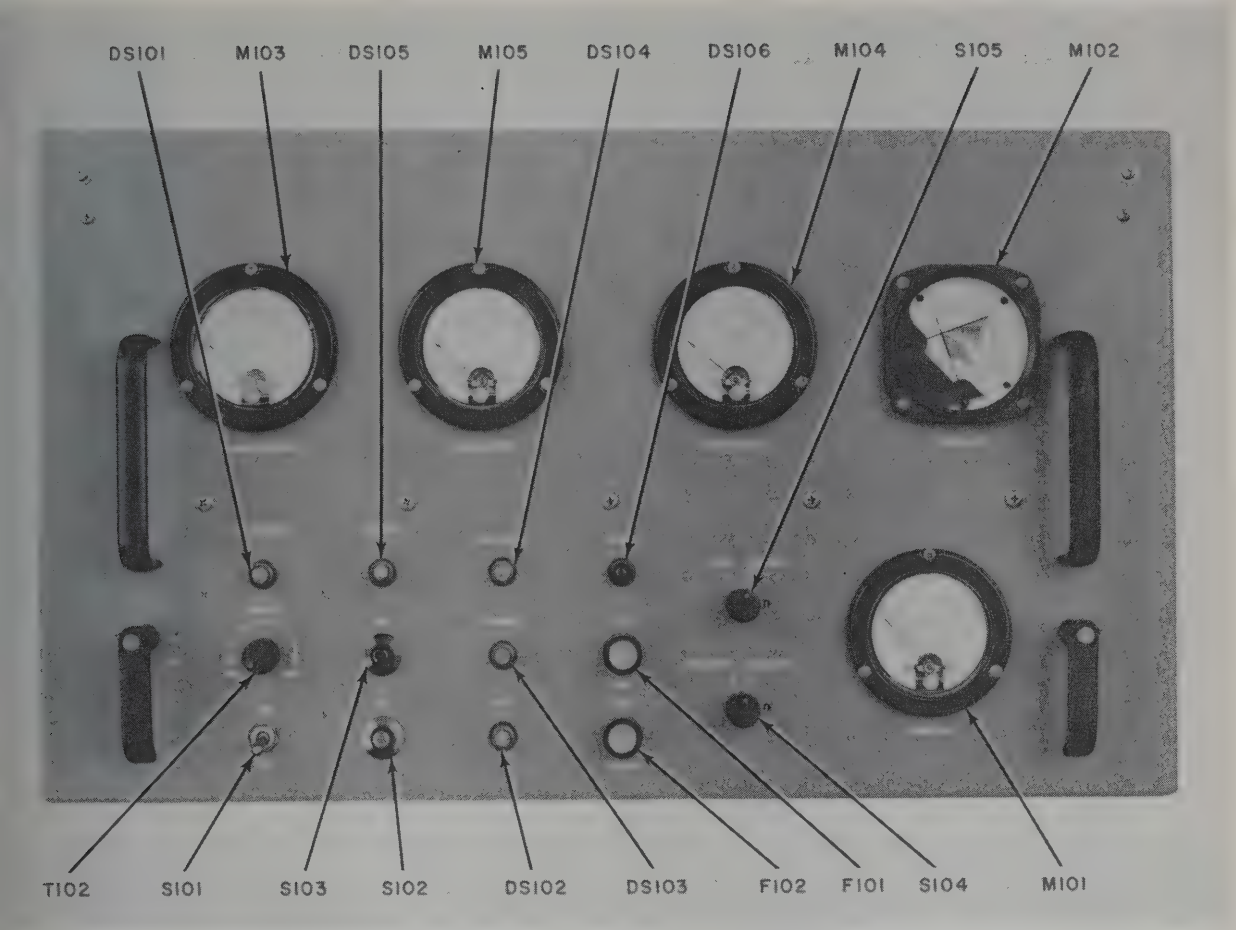


Figure 31. Power amplifier control panel drawer, front panel view.

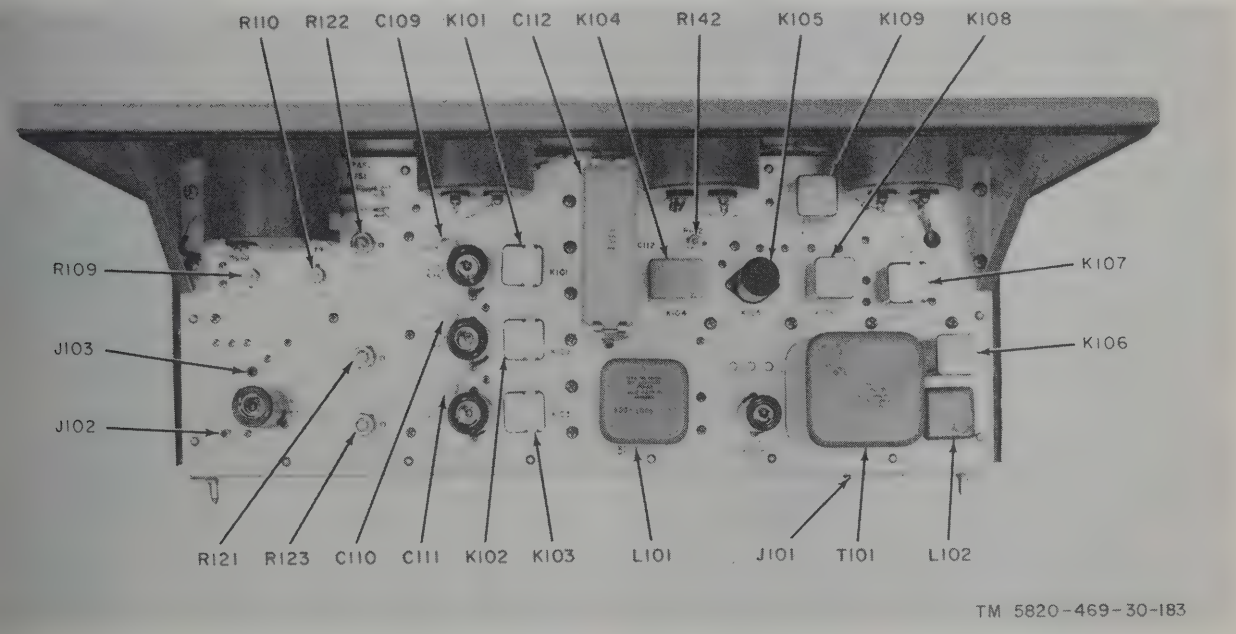


Figure 32. Power amplifier control panel drawer, top view.

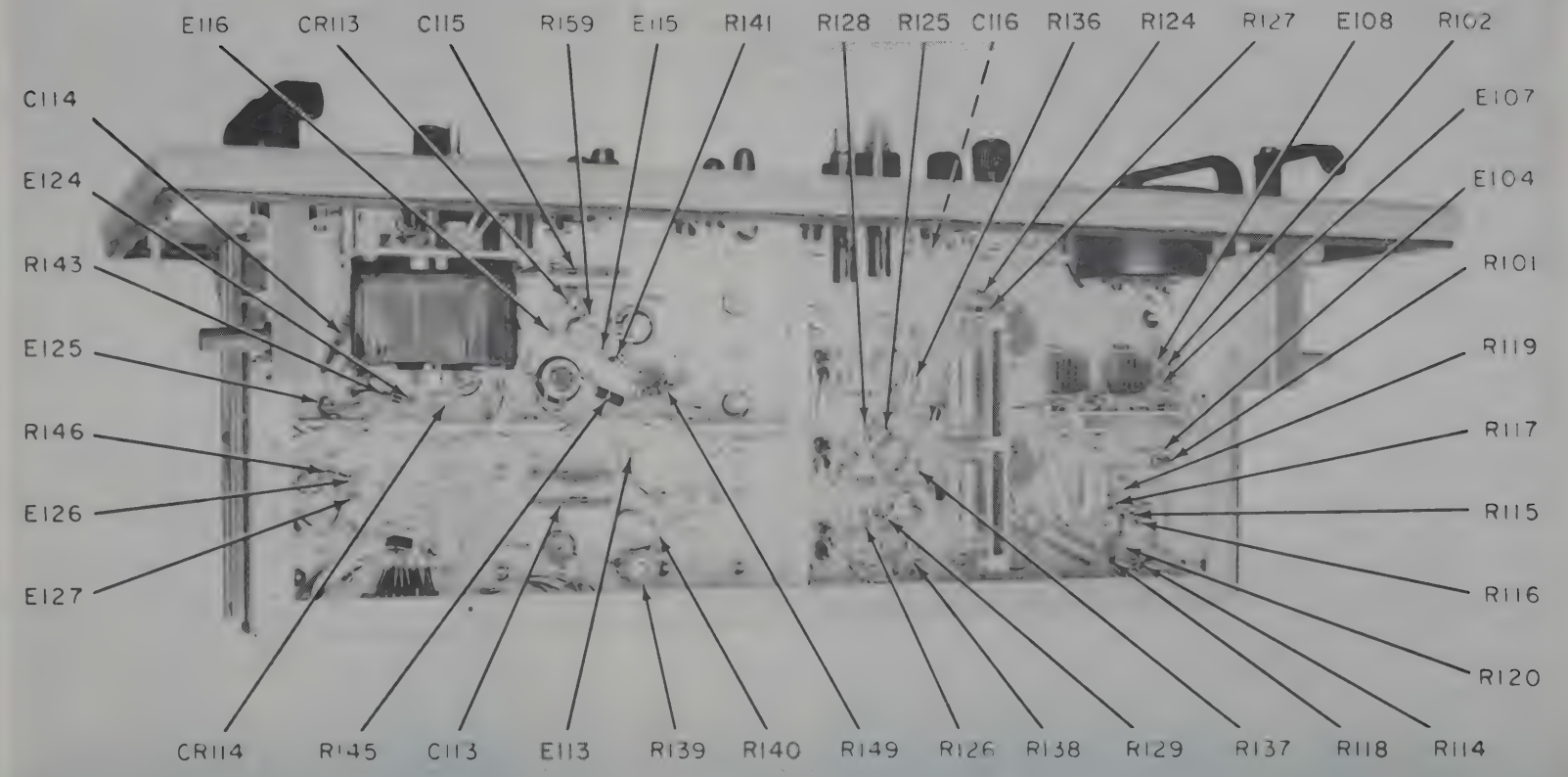


Figure 88. Power amplifier control panel drawer, bottom, left oblique view.

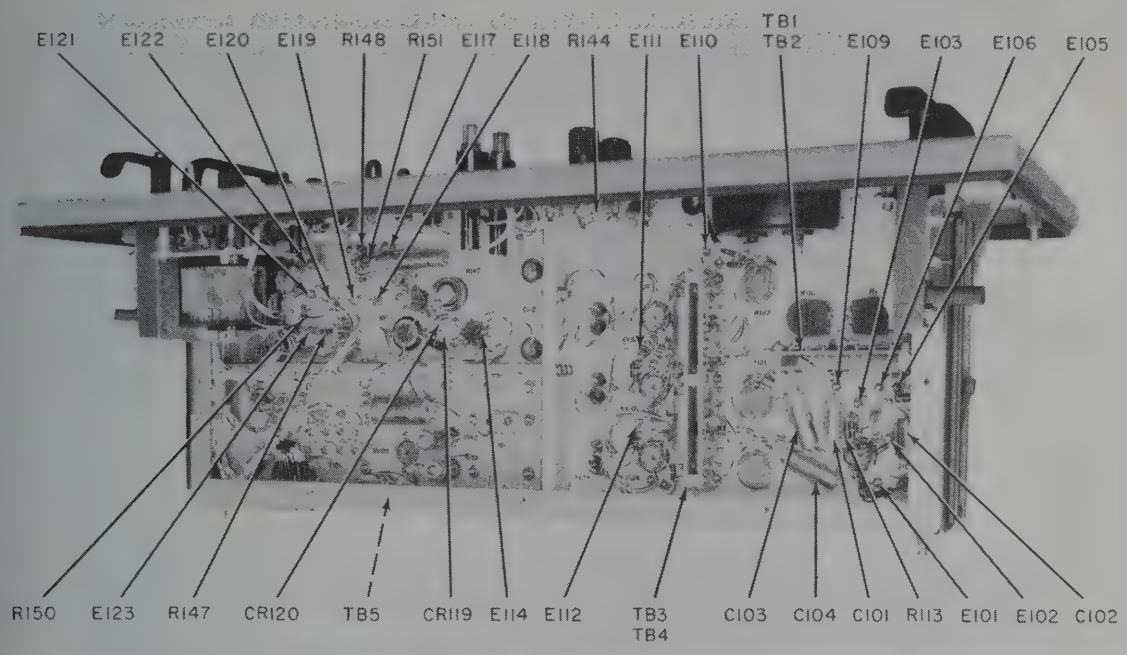
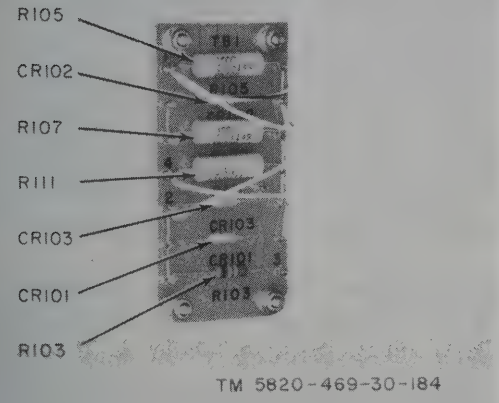


Figure 34. Power amplifier control panel drawer, bottom, right oblique view.



ure 35. Terminal board TB1 (part of control panel drawer), location of components.

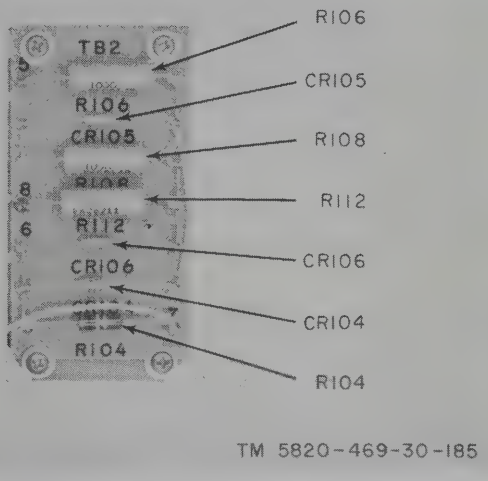


Figure 36. Terminal board TB2 (part of control panel drawer), location of components.

Caution: **Disconnect and free klystron filament connectors P301 and P302 from J301 and J302 (fig. 41) before removing the power supply drawer.**

b. When trouble symptoms indicate that no circuit breaker trips and there is no BEAM VOLTAGE indication, remove the drawer (para. 43*c*, TM 11–5820–469–20) and make a series of resistance measurements, starting with high-voltage transformer T301, to find a possible open circuit. Isolate circuits as much as possible for each measurement by removing leads that are not soldered. In particular, terminals 22, 23, and 24 to T301, and the left-hand

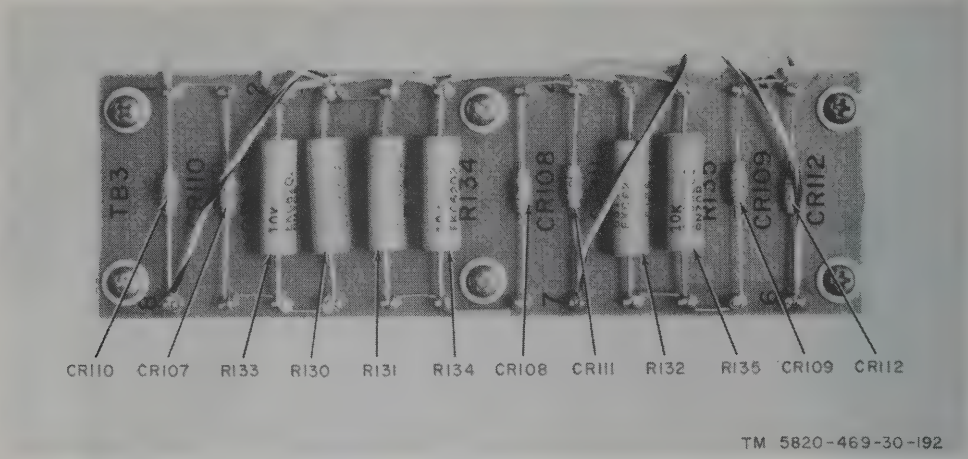


Figure 37. Terminal board TB3 (part of control panel drawer), location of components.

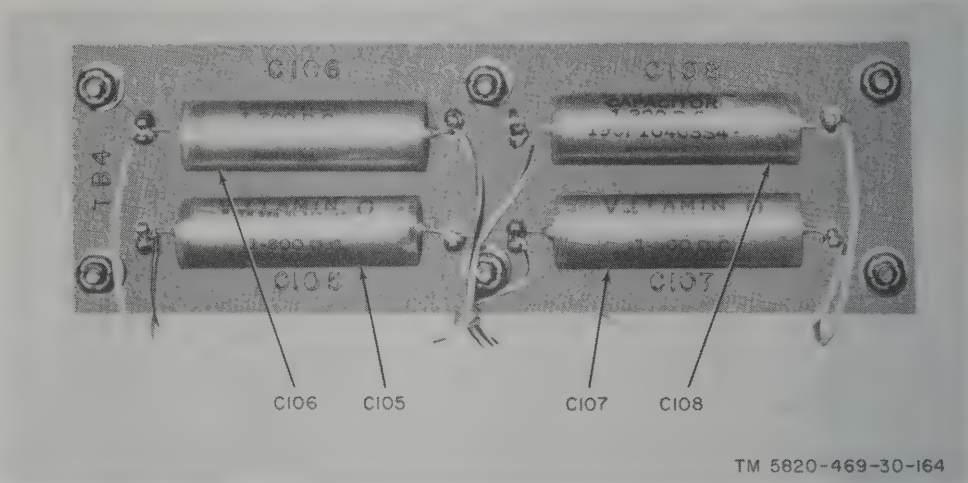


Figure 38. Terminal board TB4 (part of control panel drawer), location of components.

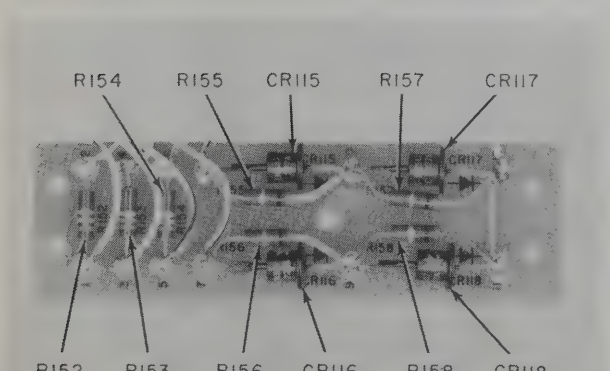


Figure 39. Terminal board TB5 (part of control panel drawer), location of components.

terminal on L301 are useful connections
break. This has the effect of isolating capa
tors C304 through C309 and diodes CR3
through CR308. Before checking C303, remem
ber to open high-voltage safety interlock S3
(fig. 41). *Do not permanently disable th
switch*; it is put there to save your life.

c. When an overload exists in the power su
ply drawer, it is easier to isolate a shorted co
ponent by checking the drawer directly with
the power amplifier cabinet where a 3-pha
400-cps supply is available. Pull out the draw
and disconnect all the components listed in (
through (5) below. Replace the drawer, tu
on the power amplifier, and depress the BEA
ON button after waiting for the required

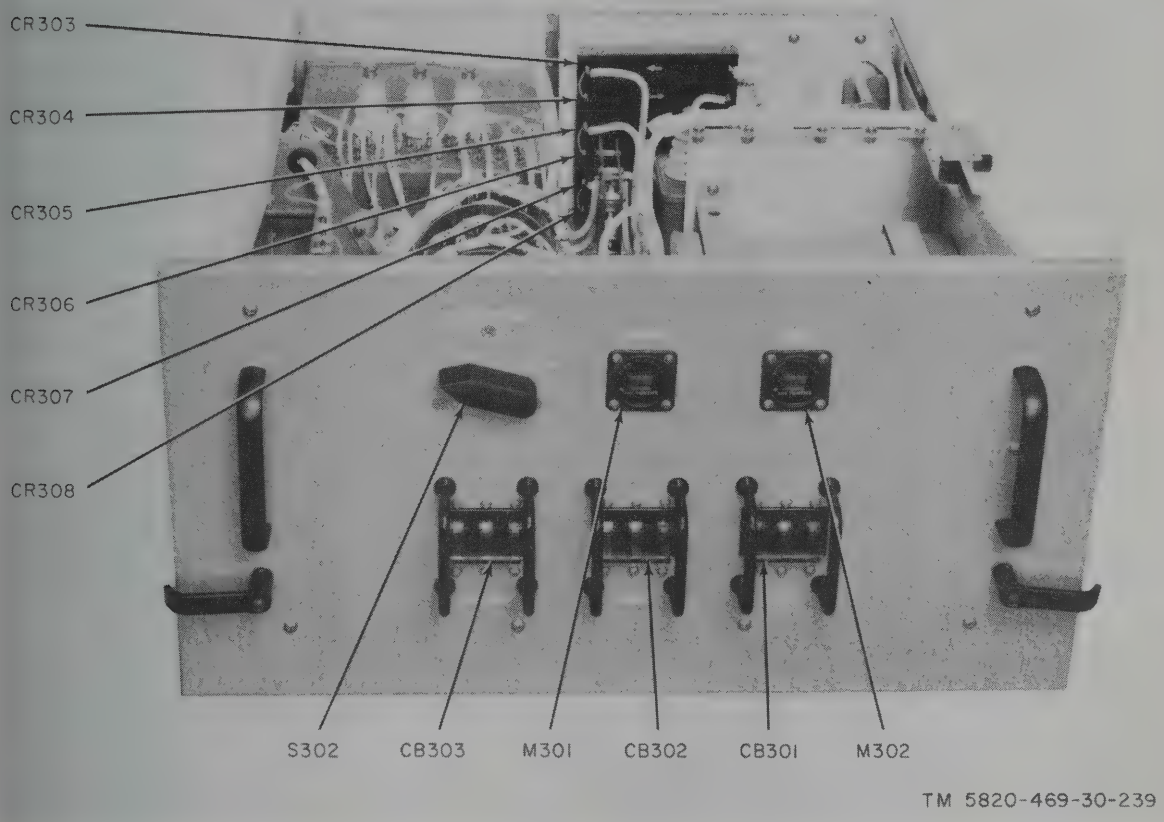


Figure 40. Pa power supply drawer, front view.

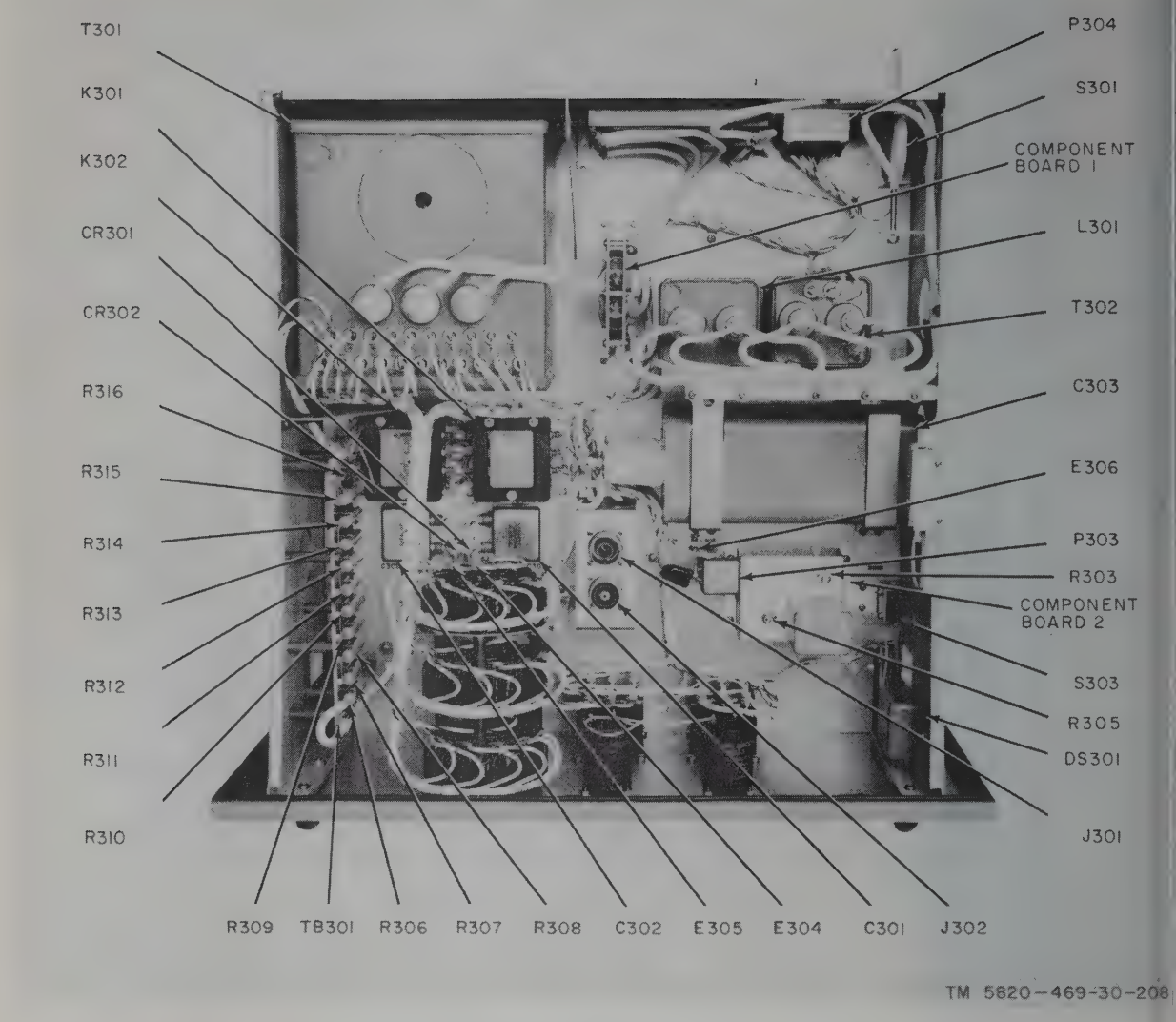


Figure 41. Pa power supply drawer, top view.

lay time. (The BEAM circuit breaker must be closed to permit the application of primary power to high-voltage transformer T301.)

(1) Filament connectors P301 and P302 (checks klystron).

(2) Klystron filament transformer terminals 3 and 4.

(3) High-voltage filter capacitor C303.

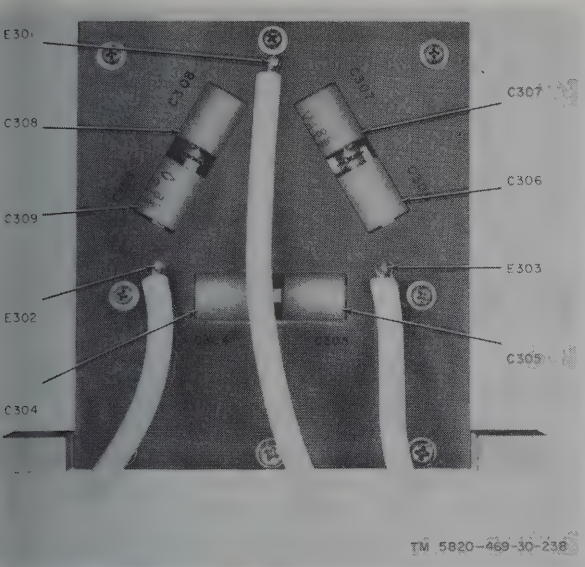
(4) Filter choke L301.

(5) Transformer T301, terminals 22, 23, and 24.

d. If the circuit breakers do not trip wi the components listed above disconnected, tu off all power and replace filament connecto P301 and P302. Replace the drawer and apj power. Replace the items (*c* above) one at time until a circuit breaker trips. The circ associated with the last connection restor contains the shorted component. Use continu measurements only to isolate the short.

223. Klystron Drawer Troubleshooting

With the exception of klystron tube V2 there are no active components within t



ure 42. Component board 1 (part of pa power supply drawer), location of components.

klystron drawer. The component locations are illustrated in figures 44 and 45. Refer to figure 159 for the complete schematic diagram. Detailed functions of the klystron drawer are covered in paragraphs 61 through 64. When trouble is encountered in the klystron drawer, check the pa tuning procedure (para. 66*b*, TM 11–5820–469–10) and perform the klystron cavity tuning adjustment (para. 292). The majority of defects within the klystron drawer will fall into the following categories:

a. Erratic electrical operation of one or more of the cavity internal tuning mechanisms may limit the maximum available power output or may make it impossible to tune the amplifier even though normal drive, collector voltage, and collector current are observed. Also, check the cavity tuning mechanism for binding or slippage.

b. Gas contamination within the klystron may cause ionization when high voltage is ap-

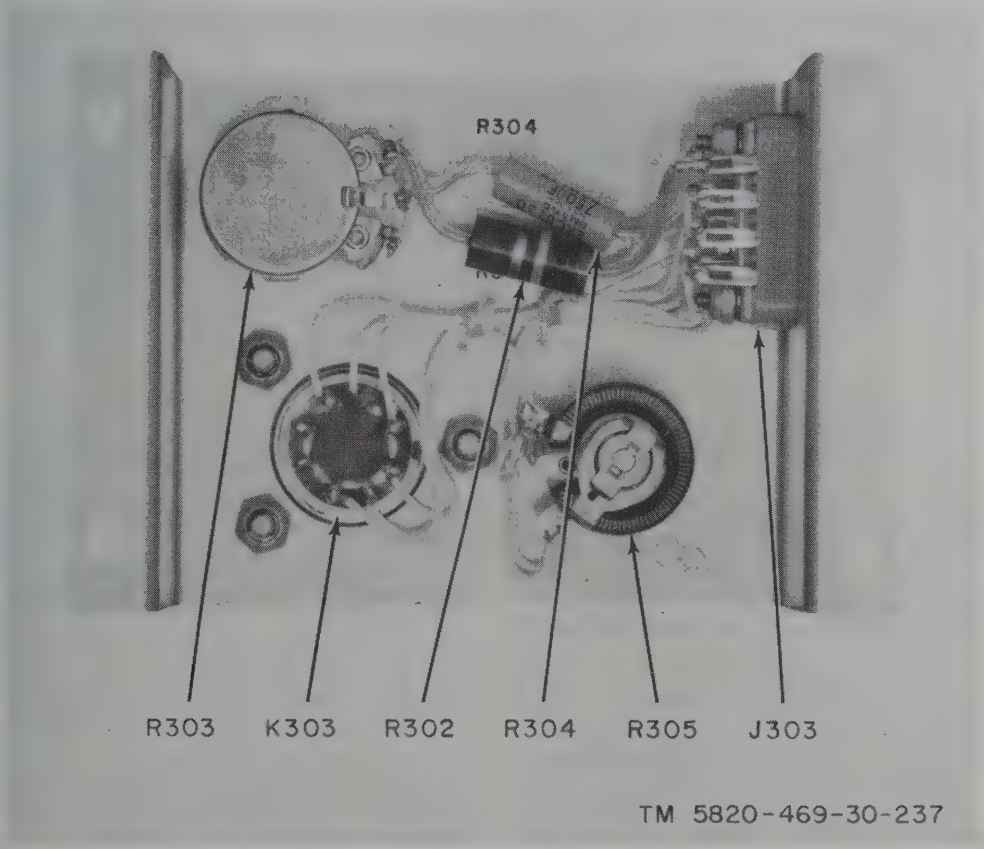


Figure 43. Component board 2 (part of power supply drawer), location of components.

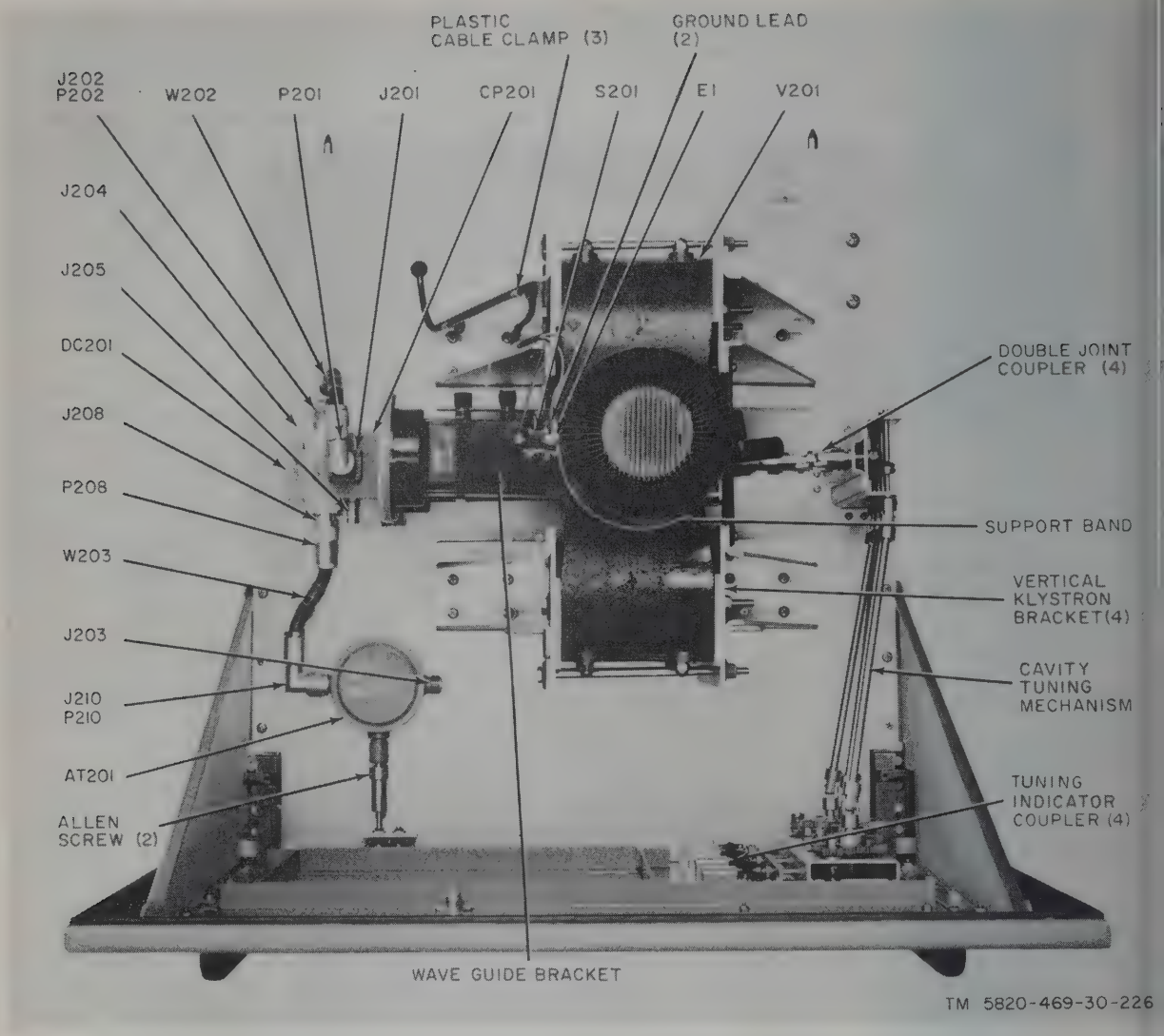


Figure 44. Pa klystron drawer, top view.

plied. Replace klystron tube V201 (para. 279*a* and *b*).

c. The klystron filament may be open or the filament cathode circuit may be shorted to the case.

d. If a replacement klystron should be installed, use procedures outlined in paragr 279. Record the serial number, reason for placement, and the filament and beam hour operation. Do *not* discard the old klystron. tain the tube for disposition as directed by maintenance supervisor or other proper thority.

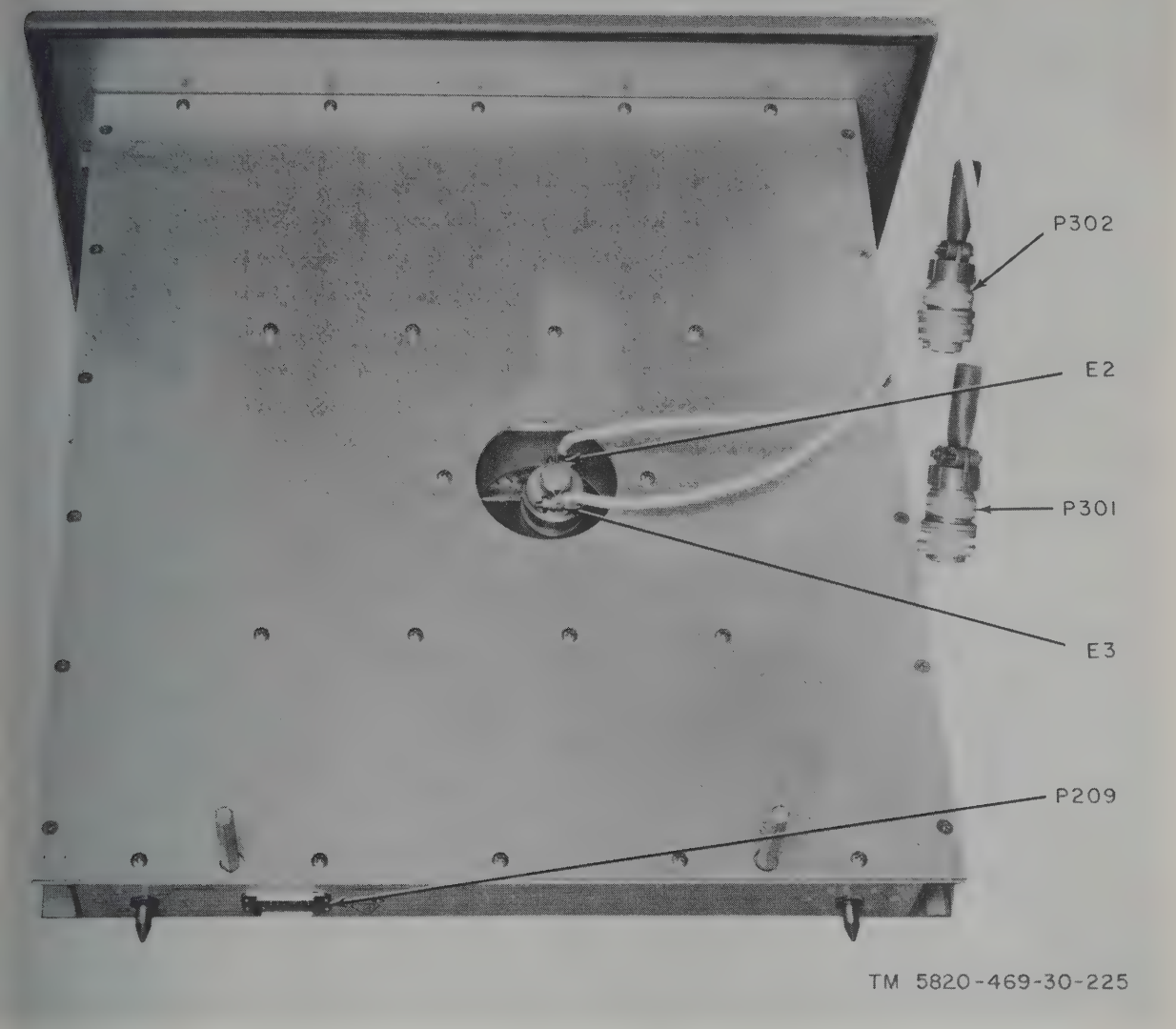


Figure 45. Pa klystron drawer, bottom view.

Section III. TRANSMIT CONVERTER TROUBLESHOOTING PROCEDURES

4. General

When the recommended checks and corrective measures given in the organizational maintenance transmit converter troubleshooting chart (para. 28, TM 11–5820–469–20) do not restore normal operation and the checks given in paragraph 218 indicate that the defect is located in the transmit converter, perform the applicable procedures described in paragraphs 225 through 231. Figures 46 through 49 illustrate the transmit converter component locations and provide voltage and resistance data. Refer to figures 155 through 157 for the complete schematic diagram, and to paragraphs 49 through 56 for the functional details.

225. Transmit Converter Troubleshooting

Note. The removal procedures for the transmit converter are covered in paragraph 41 of TM 11–5820–469–20.

a. Test Connections. Set the transmit converter chassis on a service bench and use the

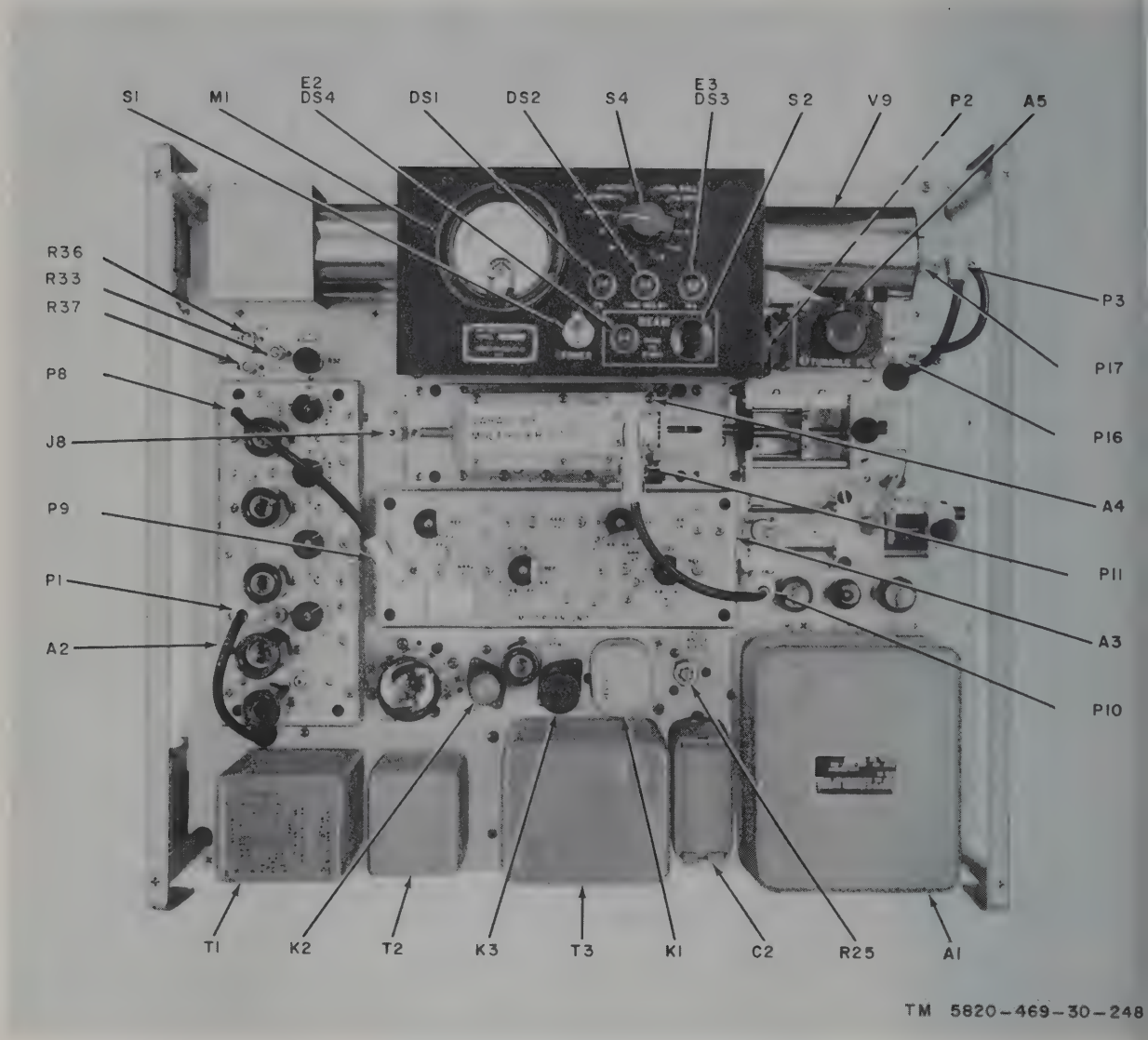


Figure 46. Amplifier-Converter AM-3303/TRC-80, front view, dust cover removed.

special power cord (24, fig. 150) to make the necessary 60-cps power connections at TB1 (fig. 23, TM 11-5820-469-20). Remove the protective backplate and replace it with the the special backplate located inside the blower kit (fig. 150). Bypass interlock switch S5 (fig. 47) by pulling the shaft out until it locks. Use the special blower supplied with the test facilities kit and connect the flexible hose between the blower and the hole in the special backplate.

Caution: **When BEAM PUSH-TO-START switch S2 is depressed, it is essential that the traveling wave tube be supplied with forced air, otherwise this tube will overheat and permanently damaged. In normal operatio the entire chassis receives forced-air coolin but during maintenance procedures only t traveling wave tube has to be cooled.**

Note. Interlock switches S3 and S5 (fig. 47) must energized before power can be applied to V9.

b. Test Signal Input. The test signal inp requirements for the transmit converter a identical with those required for the recei converter. Refer to paragraph 241*b* for t test signal connections.

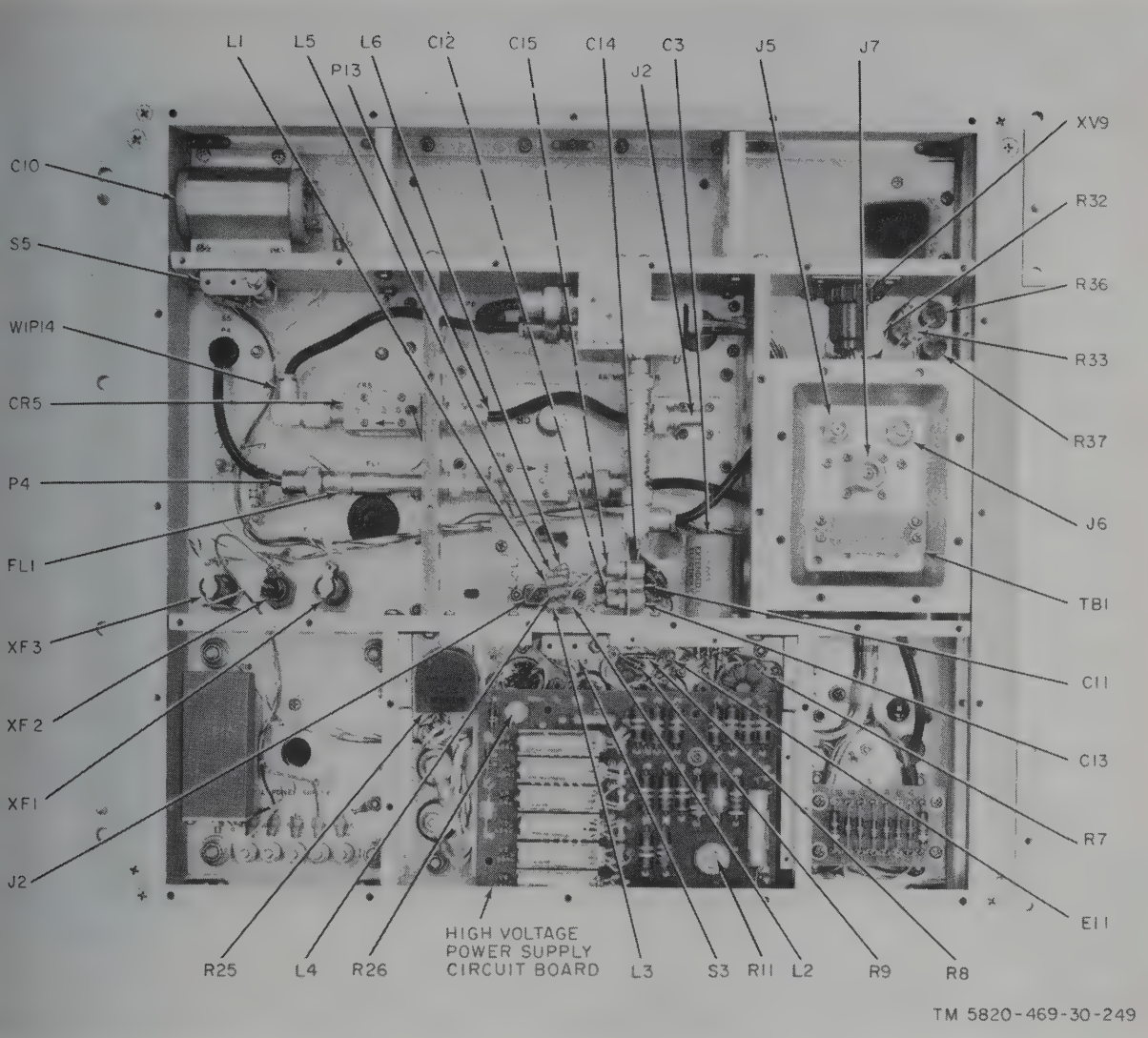


Figure 47. Amplifier-Converter AM–3303/TRC–80, rear view, cover removed.

. *Troubleshooting Procedure.* The transmit verter localizing procedures described in ragraph 218 will localize the defect to one the modules or subchassis (oscillator, multi-er, varactor multiplier, traveling wave tube, .) which comprise the transmit converter. fer direct to the paragraph in this section t covers the troubleshooting procedures for suspected module or subchassis. When no ter indications are obtained, or if the B+ icator does not light, refer to the transmit verter 200-volt power supply A1 trouble-ooting procedures (para. 231).

226. Oscillator Unit Troubleshooting Procedures

Note. When the AN/TRC–80 is used as part of the Pershing Weapons System, EXT-INT switch S1 is normally set to EXT (signal input from synthesizer). In this application, a failure within oscillator stage V1 cannot affect normal operation.

a. Failure to obtain satisfactory readings on meter M1 when METER FUNCTION SELECTOR switch S4 is in the A or NULL A position (para. 218, steps 1 and 2) indicates that a defective component may be located in oscillator V1A or cathode follower V1B. An incorrect

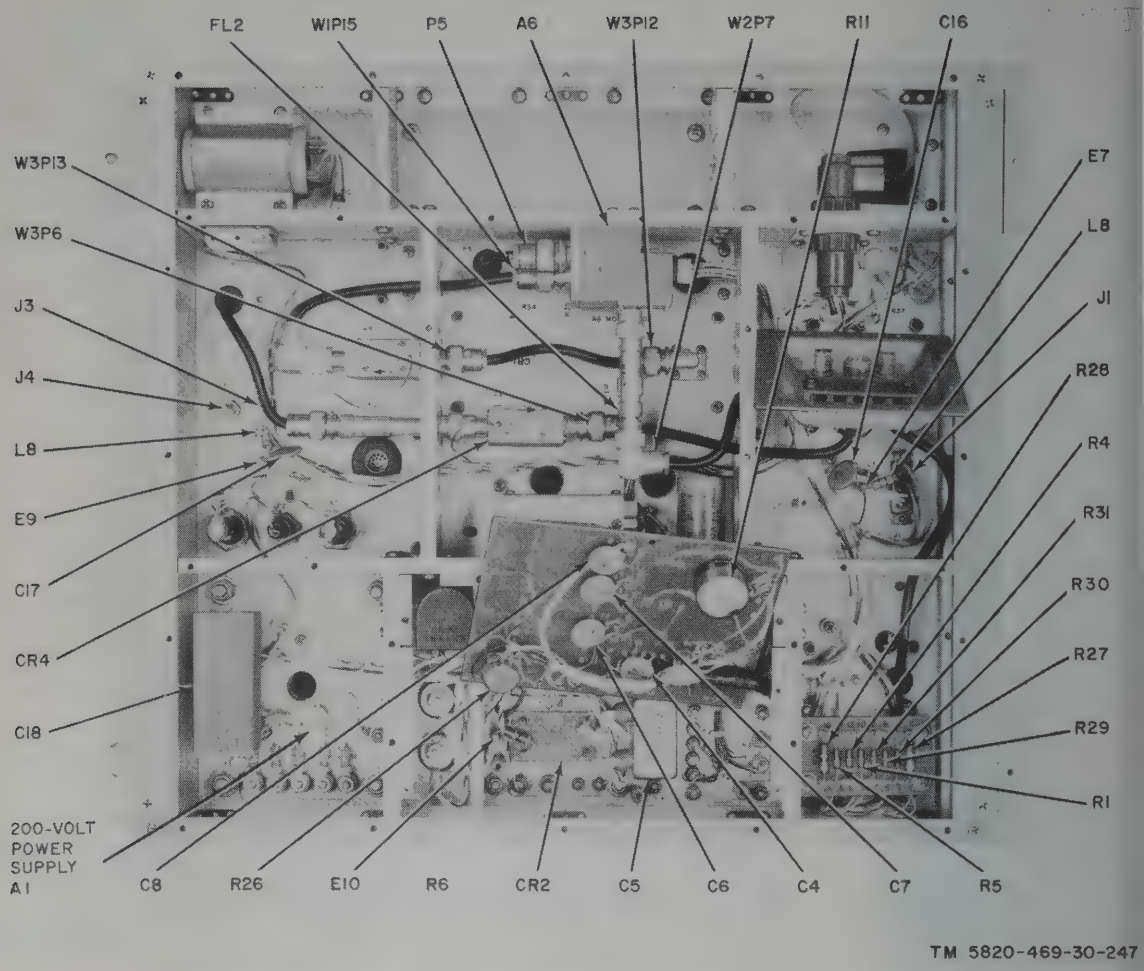


Figure 48. Amplifier-Converter AM–3303/TRC–80, rear view, component boards removed.

meter reading with S4 in the B position indicates that the defect may be located between buffer amplifier V2 and buffer amplifier V4. Before removing the oscillator unit for troubleshooting, perform the following check:

(1) Connect the transmit converter as directed in paragraph 225*a* and *b*.

(2) Set LEVEL ADJUST control R32 (mounted on the transmit converter chassis) to the maximum clockwise position.

(3) Disconnect plug P9 from multiplier unit jack J1 (fig. 55).

(4) Connect the 20-db attenuator (test facilities kit, fig. 150) to plug P9.

(5) Connect Adapter, N female to T female (item 10, test facilities fig. 150) to the attenuator (above).

(6) Connect Radio Frequency Power T Set AN/USM–96A to the adapter (above).

(7) Adjust R32 for an indication of proximately 2.5 milliwatts.

(8) If an indication of 2.5 milliwatt obtained, check the connections meter M1 on the transmit conver If an indication of 2.5 milliwatts is obtained, proceed to *b* below.

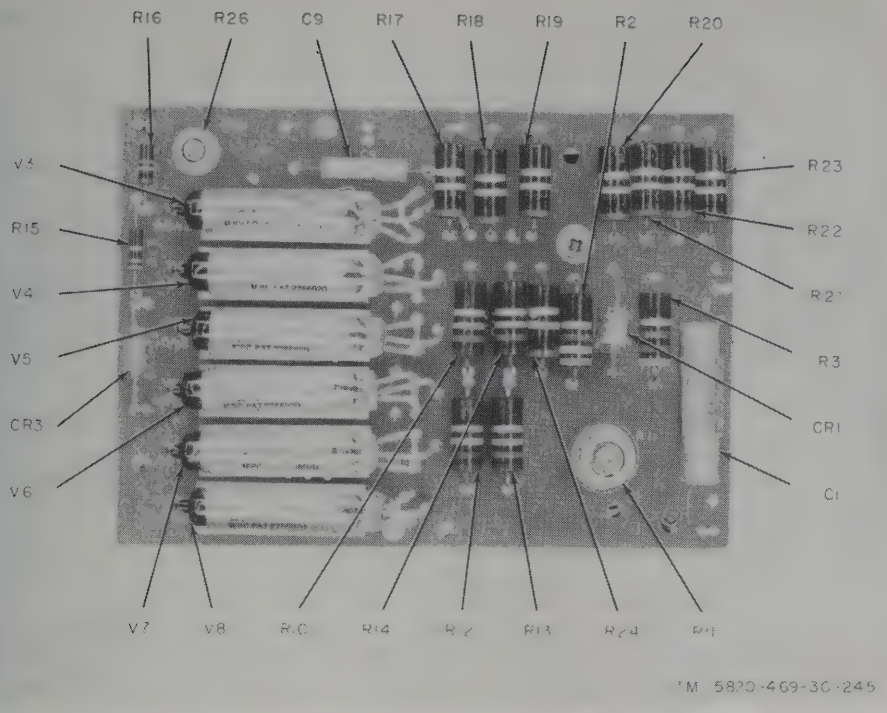


Figure 49. Voltage-regulator board, part of transmit converter, location of components.

To prepare the oscillator unit for trouble-ting or repairs, remove it from the trans-converter chassis (para. 278*j*) and connect test cable extender (item 28, test facilities fig. 150) between P1 (fig. 52) and J1 on the smit converter. Refer to figures 51, 52, 53 for the component locations, and to fig-155 for the complete schematic diagram. form the voltage and resistance measure-ts (fig. 54) to locate the defective compo-.

te. Oscillator unit A1 in the receive converter is ical with oscillator unit A2 used in the transmit erter. The troubleshooting procedures are similar t that the test cable extender is connected between the oscillator unit and J5 (fig. 73) on the receive erter main frame.

Multiplier Unit Troubleshooting Procedures

ution: **The tubes in the multiplier unit me much warmer during operation when ed-air cooling is not available. Unless s can be concluded within a few minutes, ove the bottom cover from the multiplier and position the second flexible airhose (from the blower unit (fig. 150) in the test facilities kit) directly on the tubes.**

a. Failure to obtain satisfactory meter indication (para. 218, steps 4 through 7) when S4 is set to position C, D, E, or F indicates that a defect probably exists within one of the four frequency multiplier stages (V1 through V4). To isolate trouble definitely to the multiplier unit, perform the following check:

(1) Verify normal operation of the oscillator unit (para. 226).

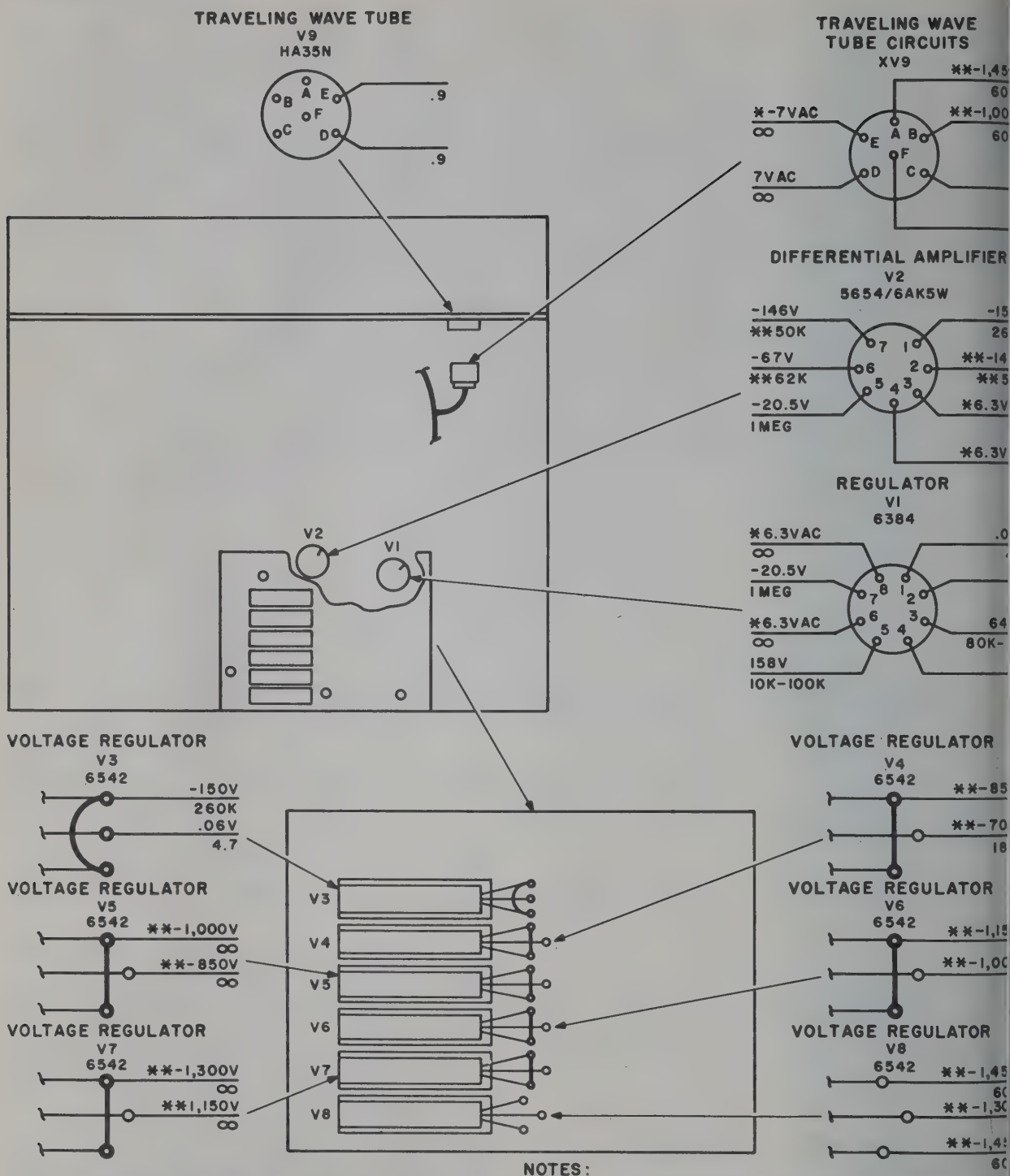
(2) Disconnect P11 from jack J1 (fig. 59) on the varactor multiplier.

(3) Connect the 20 db attenuator (item 3, test facilities kit, fig. 150) to plug P11.

(4) Connect Adapter, N female to TNC female (item 10, test facilities kit, fig. 150) to the attenuator ((3) above).

(5) Connect Radio Frequency Power Test Set AN/USM-96A to the adapter.

(6) If an indication of approximately 5.25 milliwatts is obtained, check for de-



NOTES:

1. VOLTAGE MEASURED TO GROUND WITH A VTVM, TWT PLUG XV9 DISCONNECTED, AND BEAM SWITCH ON
2. RESISTANCE MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER, ALL POWER DISCONNECTED
3. VOLTAGE READINGS ARE ABOVE THE LINE, RESISTANCE READINGS ARE BELOW THE LINE
4. BOTH AIR INTERLOCK SWITCHES MUST BE PULLED OUT FOR BENCH OPERATION
5. THE TRAVELING WAVE TUBE MUST HAVE COOLING AIR DURING ANY PERIOD OF OPERATION
6. VOLTAGE MEASUREMENTS FOR THE TRAVELING WAVE TUBE ARE TO BE MADE AT PLUG XV9 WHIL DISCONNECTED

* MEASUREMENTS ARE MADE PIN TO PIN WITH A MULTIMETER

** VALUE DEPENDS ON ADJUSTMENT OF R11 AND R

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Figure 50. Amplifier-Converter AM-3303/TRC-80, voltage and resistance diagram.

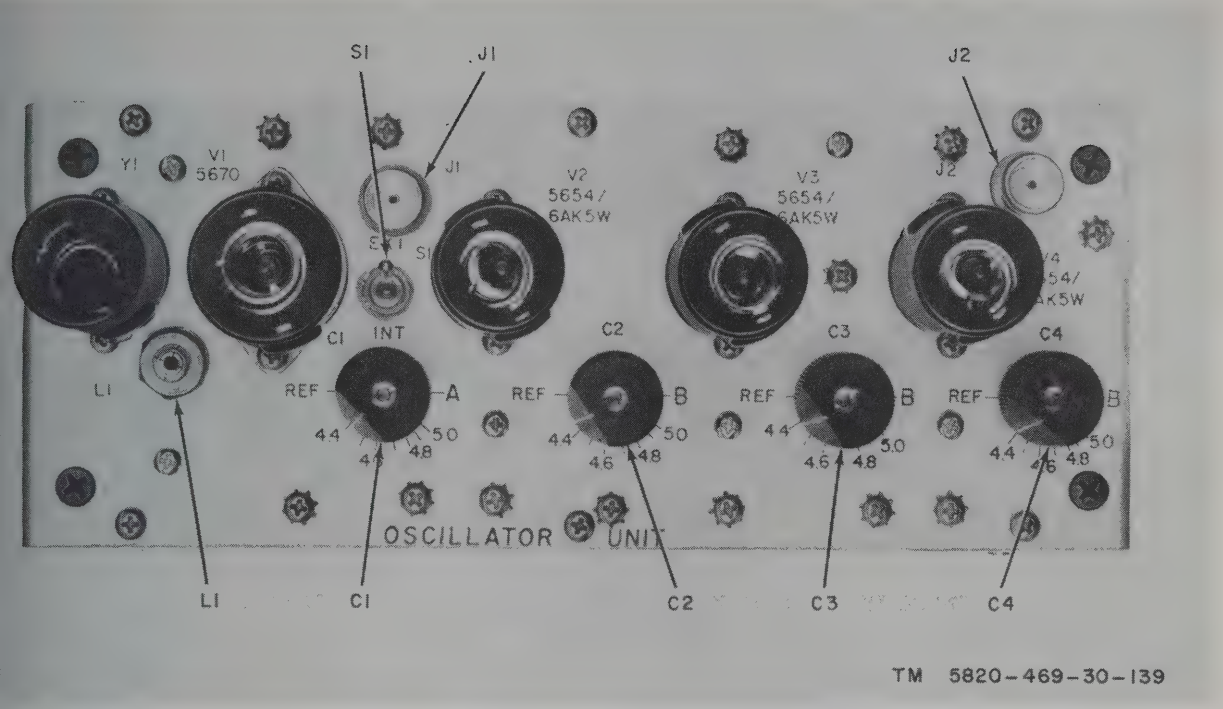


Figure 51. Oscillator unit A2, top view, location of components.

fects external to the multiplier unit. If an indication of 5.25 is not obtained, proceed to *b* below.

Note. Screwdriver-adjustable control R33 (fig. 46) is a meter-sensitivity adjustment for position F of S4. This control is factory adjusted and should *not* be touched in the field.

To prepare multiplier unit A3 for trouble-ting or repairs, remove the multiplier from transmit converter chassis (para. 278*m*) connect the test cable extender (item 28, facilities kit, fig. 150) between P1 (fig. 56) J2 (fig. 47) on the transmit converter. 'orm the voltage and resistance measure-ts to locate the defective component. Refer gures 55, 56, and 57 for the component lo-ons, and to figure 156 for the complete matic diagram. Figure 58 lists the voltage resistance data.

te. Multiplier unit A3 in the transmit converter is ical with multiplier unit A2 used with the receive erter. Troubleshooting procedures for both multi- units are similar except that the test cable ex-r is connected between P1 on the multiplier unit J6 on the receive converter (fig. 73).

228. Transmit Converter Varactor Multiplier Troubleshooting Procedures

a. Failure to obtain satisfactory meter indication (para. 218, steps 8 and 9) when meter function selector switch S4 is set to position G or H indicates that a defect probably exists in the varactor multiplier unit or the associated detector, CR1 (fig. 61). To isolate trouble definitely to the varactor multiplier, perform the following checks:

Note. The transmit converter must be connected as specified in paragraph 225*a*.

(1) Verify that both the oscillator and multiplier units are operating normally (paras. 226 and 227) before testing the varactor multiplier.

(2) Remove W3P13 (fig. 48) from RF signal detector CR5 (fig. 47).

(3) Connect the 10 db attenuator (item 1, test facilities kit, fig. 150) to the input of Radio Frequency Power Test Set AN/USM-96A. Connect Adapter, N female to TNC female (item 10, test facilities kit, fig. 150) between the attenuator and P13.

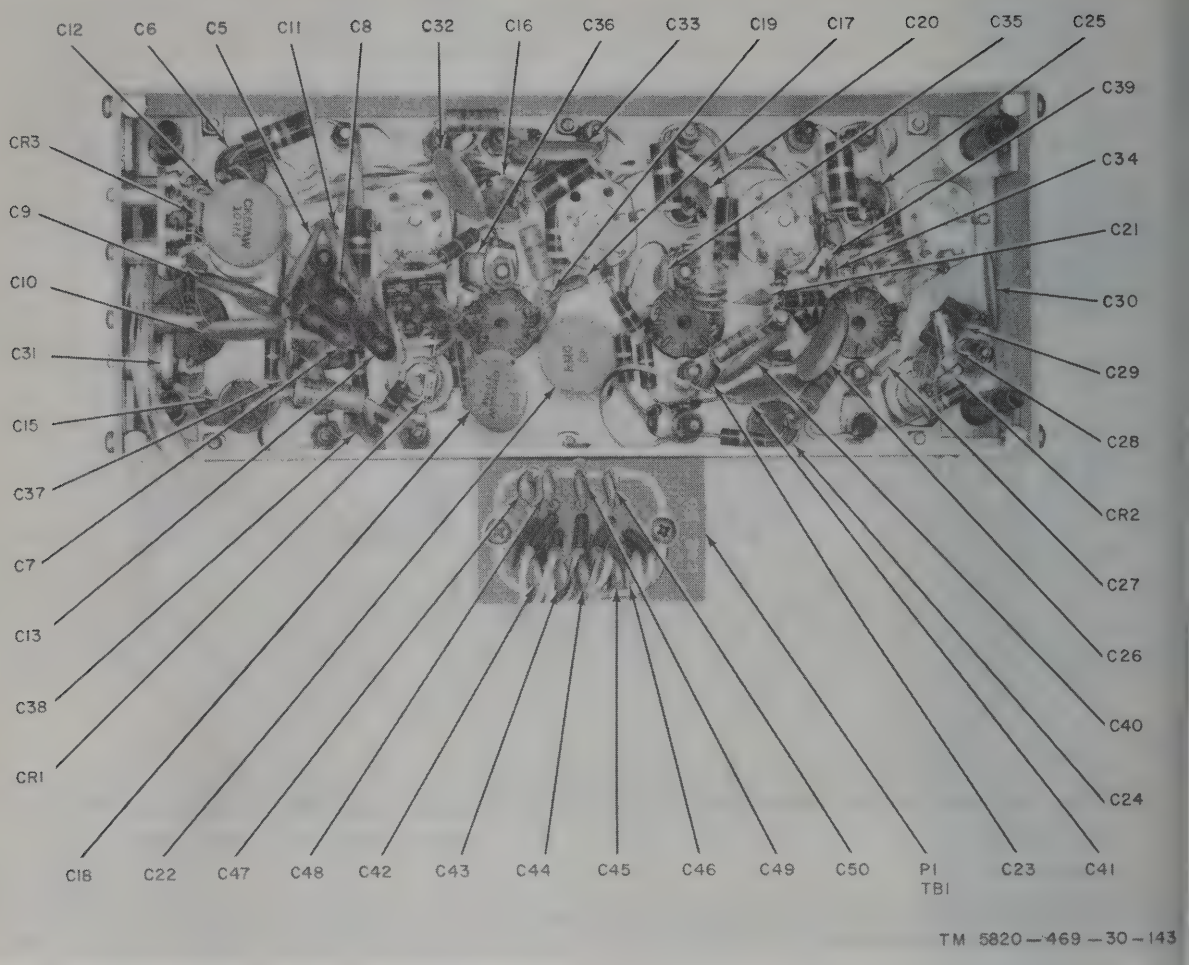


Figure 52. Oscillator unit A2, bottom view, location of capacitors.

(4) Turn on the power. The AN/USM–96A should indicate approximately 2.2 milliwatts. If this reading is normal, proceed to (5) below. If the reading is abnormal, the varactor multiplier is defective and should be replaced. Refer to paragraph 278*n*.

(5) Remove cable W1P15 (fig. 48) from balanced modulator A6. Measure the output power at P15, using the same attenuator and adapter ((3) above). The AN/USM–96A should indicate approximately 2.2 milliwatts. If this reading is not obtained, replace RF signal detector CR5.

(6) If the tests given in (4) and (5) above indicate normal operation, check the connections from the var tor multiplier to meter M1.

b. Refer to figures 46, 47, and 48 for the cations of components associated with the ractor multiplier. Figures 59, 60, and 61 ill trate the components mounted on (or with the varactor multiplier subchassis. Figure is the complete schematic diagram.

229. Balanced Modulator A6 and Tunabl Filter A5 Troubleshooting Procedure

a. General. Failure to obtain a satisfact meter indication (para. 218*b* step 12) w meter function selector switch S4 is set tc OUTPUT indicates that trouble exists betw the output of the varactor multiplier (par. 2

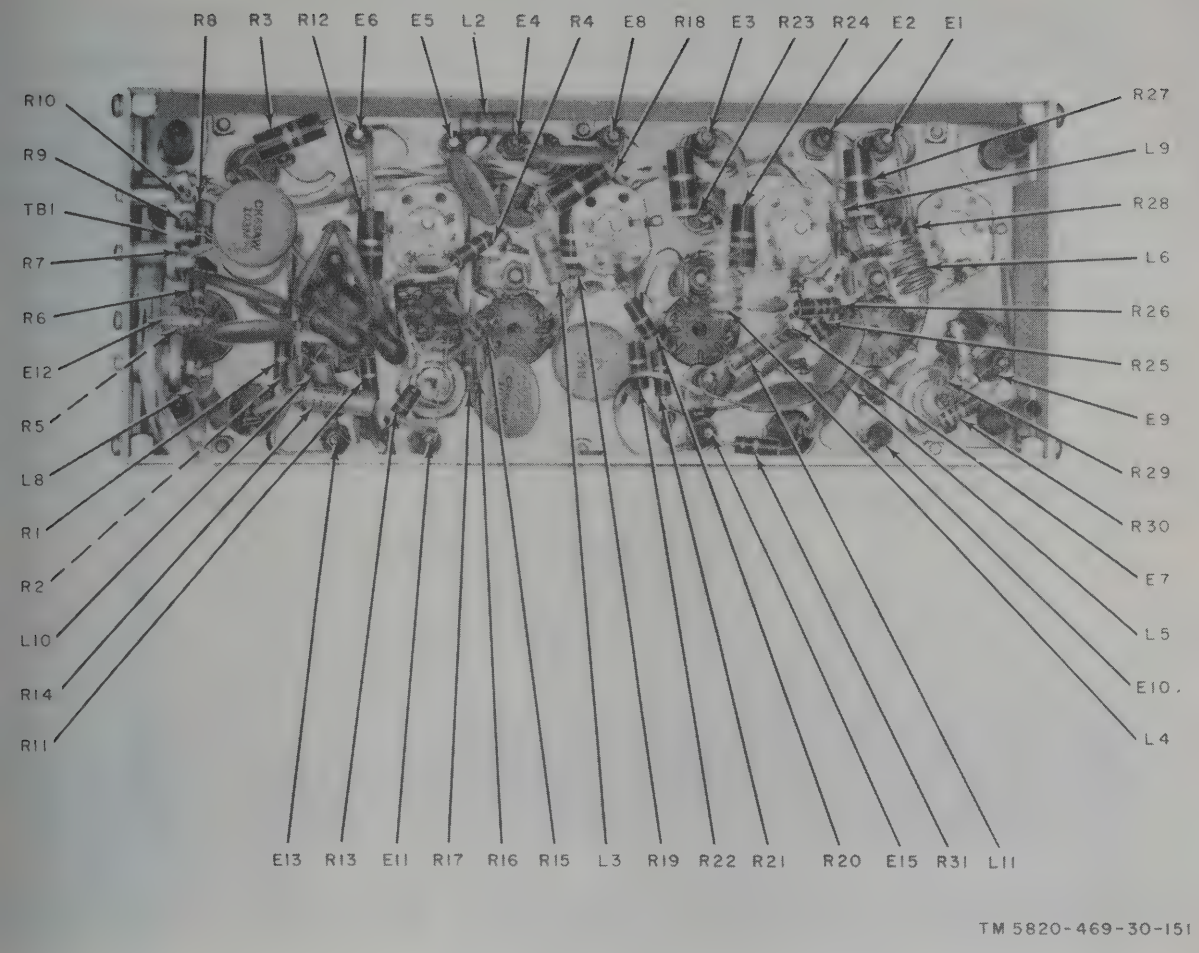


Figure 53. Oscillator unit A2, bottom view, location of components.

d the output of the transmit converter jack, (fig. 23, TM 11–5820–469–20). Before test- the balanced modulator of the tunable filter and *c* below), perform the checks listed be- v:

Note. Connect the transmit converter as specified in ragraph 225*a*.

(1) Verify that both the oscillator and multiplier units are operating normally (para. 226 and 227).

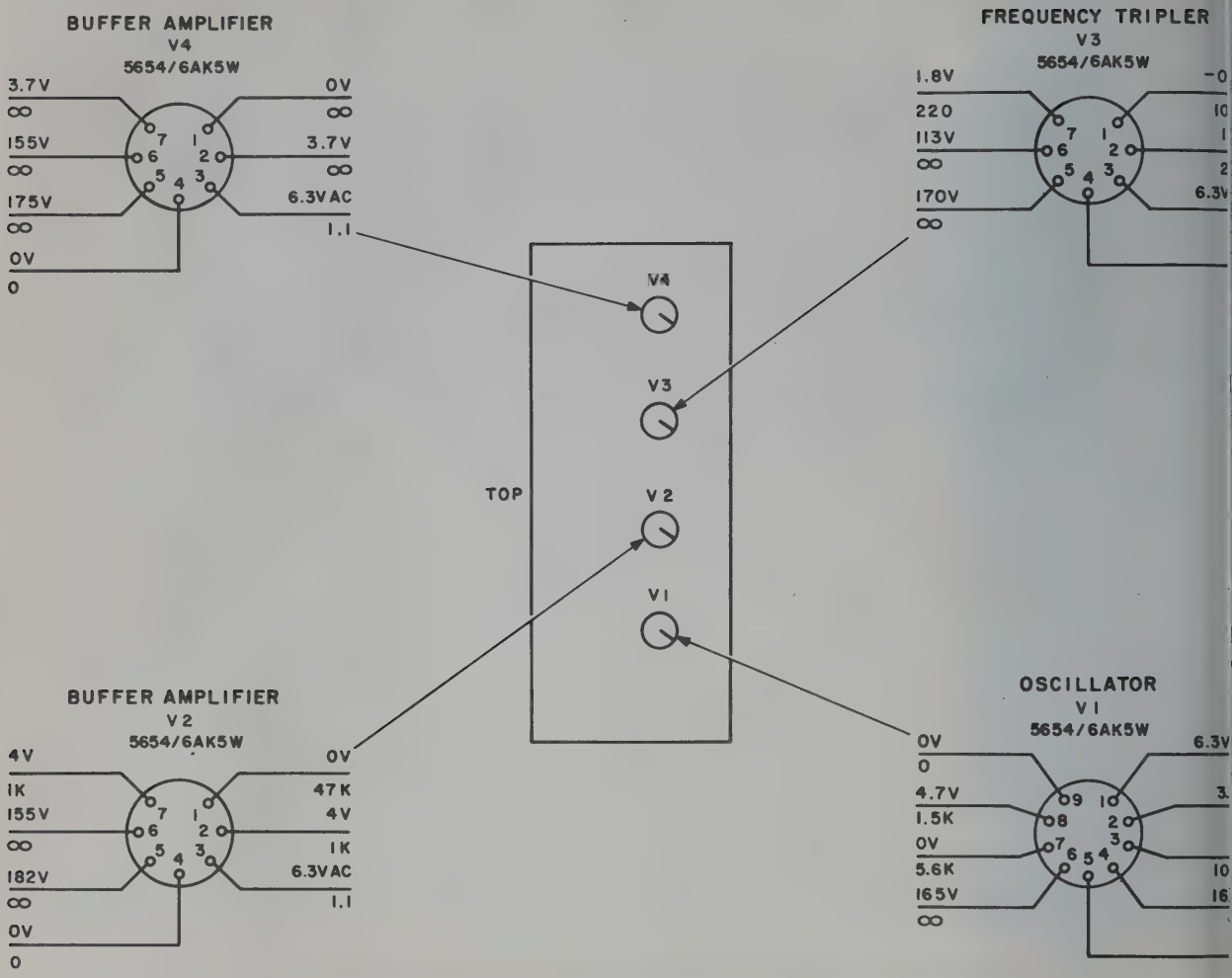
(2) Verify that the varactor multiplier is functioning normally (para. 228).

b. Balanced Modulator A6. Modulator-Multiplier MD–465/TRC–80 is used as the 70-mc urce for this test. It is not necessary to use y modulation.

(1) Apply power to the modulator-multiplier by connecting a 115-volt ac input to terminals 1 and 2 of TB1 (fig. 24, TM 11–5820–469–20).

(2) Use the BNC–BNC test cable (item 19, fig. 150) and connect 70 MC OUTPUT jack J6 (fig. 24, TM 11–5820–469–20) to input jack J5 (fig. 47) on the rear panel of the transmit converter.

(3) Remove output cable connector P5 (fig. 48) from balanced modulator A6. Connect Adapter, TNC right angle (item 6, fig. 150) to the balanced modulator. Connect Adapter, N female to TNC male (item 9, fig. 150), the 10 db attenuator (item 1, fig. 150),



NOTES:

1. VOLTAGES MEASURED TO GROUND WITH A VTVM, WITH ALL UNITS INSTALLED, VOLTAGE APPLIED FROM THE CONVERTER POWER SUPPLY, CRYSTAL Y1 REMOVED, AND NO EXTERNAL SIGNAL APPLIED
2. RESISTANCE MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER
3. FOR RESISTANCE MEASUREMENT ONLY, DISCONNECT P1 FROM J21 ON THE CHASSIS
4. VOLTAGE READINGS ABOVE THE LINE, RESISTANCE READINGS BELOW THE LINE

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Figure 54. Oscillator unit A2, voltage and resistance diagram.

and the AN/USM–96A (in that order) to the right-angle TNC adapter.

(4) The AN/USM–96A should indicate approximately 2.2 milliwatts. If this indication is not obtained, see that the modulator-multiplier output at J6 is at least 200 milliwatts (para. 234*a*). If the modulator-multiplier output is normal, replace balanced modulator A6 (para. 278*c*).

c. Tunable Filter A5 (fig. 46).

Note. The tunable filter should be correctly tune before performing this test (para. 66, steps 10, 11, 1 TM 11–5820–469–10).

(1) Remove plug P17 from the travelin wave tube V9 input and connect Adap ter, N female to TNC female (ite 10, fig. 150) to P17.

(2) Connect the other end of the adapte to the AN/USM–96A.

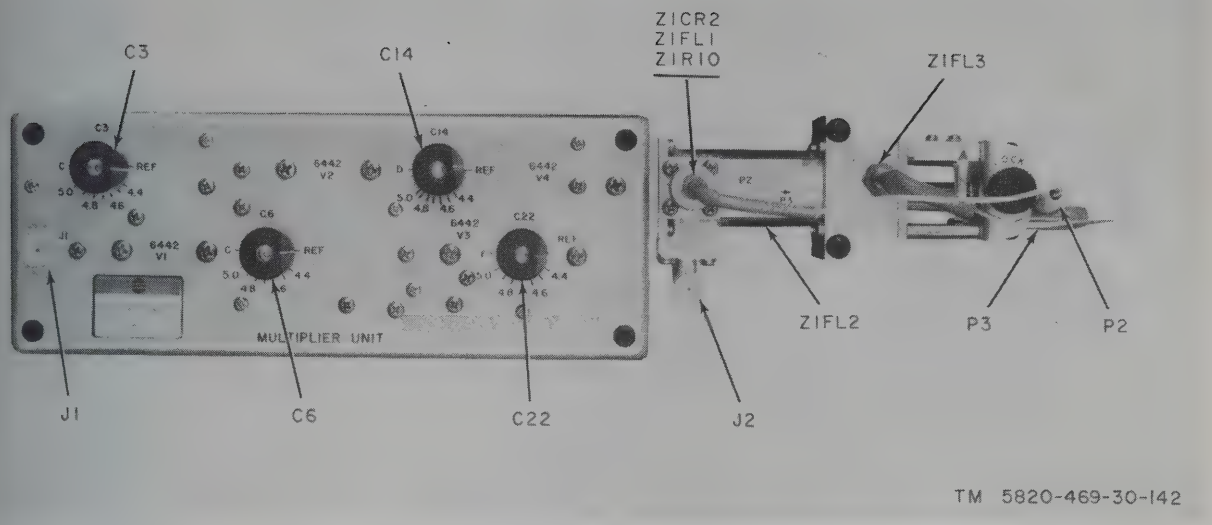


Figure 55. Multiplier unit, top view.

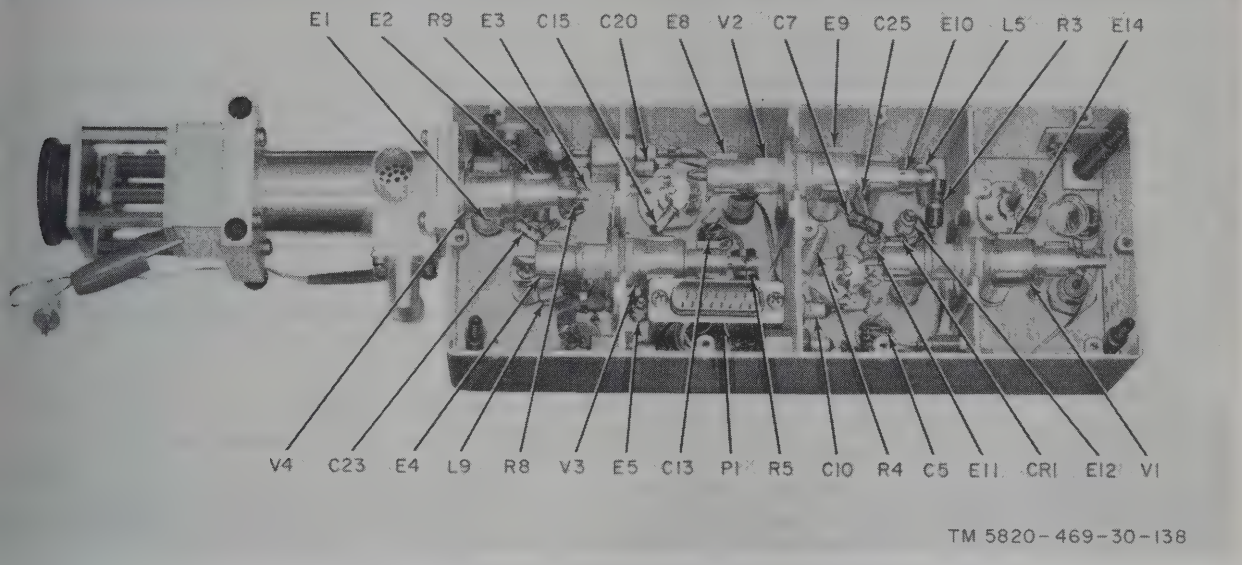


Figure 56. Multiplier unit, bottom view, cover removed.

(3) Check for a meter indication of 2.5 milliwatts on the AN/USM–96A. If this indication is not obtained and the test given in *b* above was satisfactory, replace the tunable filter (para. 278*t*).

30. Traveling Wave Tube V9 and Power Supply Troubleshooting Procedures

Note. When the transmit converter is connected as rt of the AN/TRC–80, an indication of approximately on the POWER IN meter of the pa control panel indicates that traveling wave tube V9 and its associated high-voltage power supply are functioning normally. When the transmit converter is removed from the shelter, use the following procedures:

a. General. Failure to obtain satisfactory meter indications (para. 218*b*, steps 10 and 11) when meter function selector switch S4 is set to the HELIX or COLLECTOR position indicates that the trouble exists in traveling wave tube V9 or the associated high-voltage power supply (provided that the indications in para-

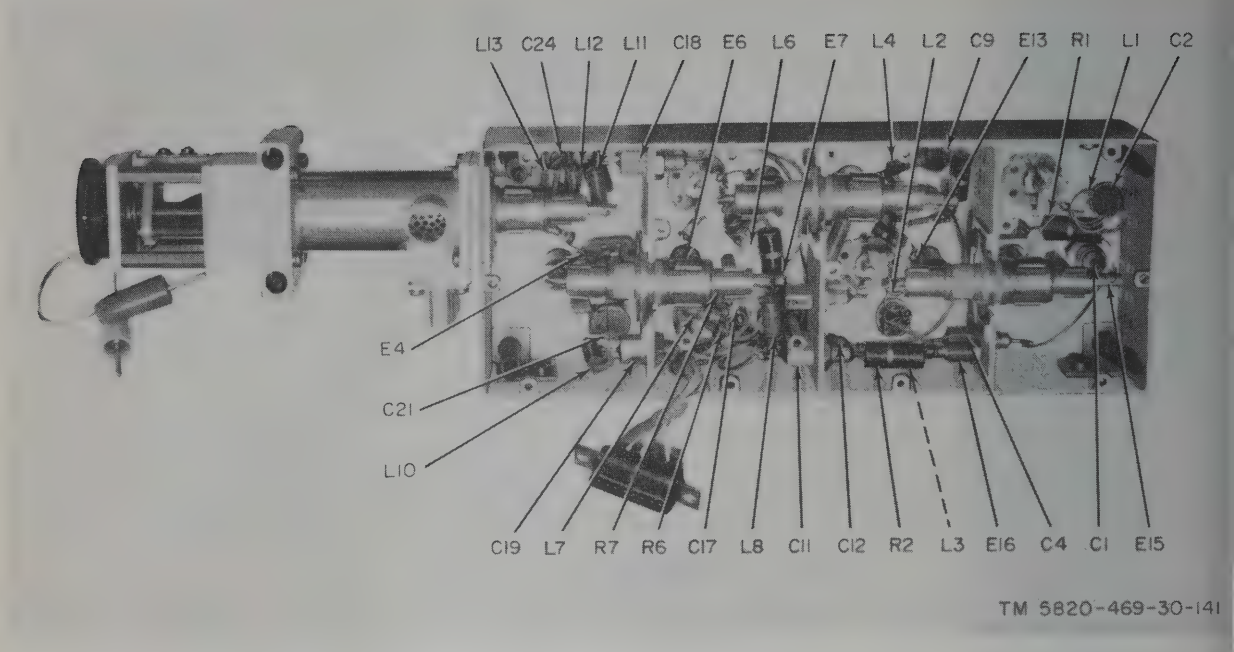


Figure 57. Multiplier unit, bottom view, cover and plug P1 removed.

graph 218(steps 1 through 9 were normal). The miniature tubes in the high-voltage regulator (V3 through V9) are illustrated in figure 49. The voltage and resistance data are listed in figure 50. Refer to figure 157 for the complete schematic diagram and to paragraph 56 for the functions of the various components in the power supply.

Warning: **Voltages in excess of 1,100 volts are exposed when the cover is removed from the traveling wave tube power supply board. Use extreme caution when making measurements on this board. Always use an insulated screwdriver when performing adjustments on R11 and R25.**

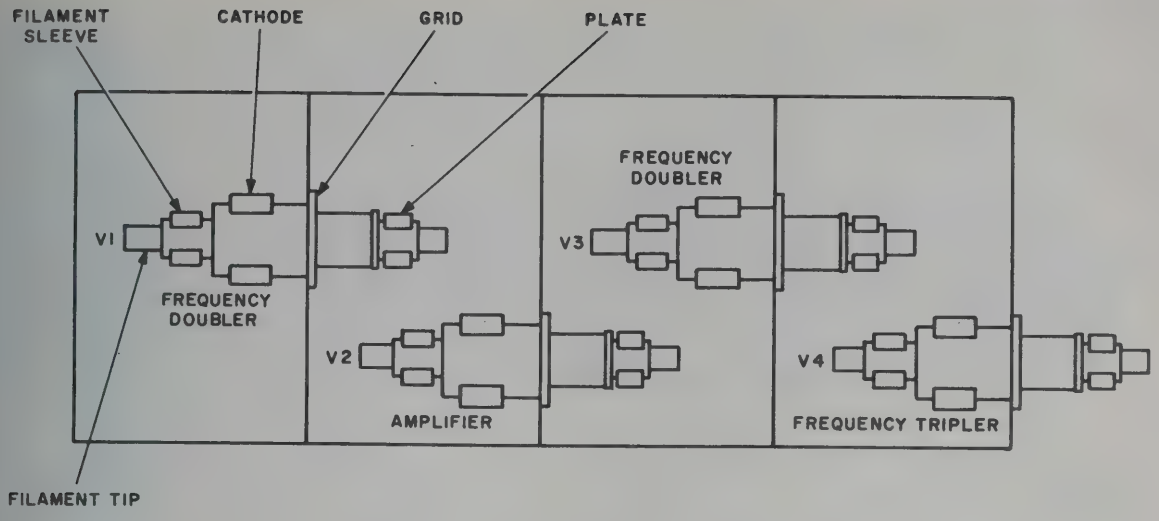
Note. Connect the transmit converter as specified in paragraph 225*a*.

b. Traveling Wave Tube Power Supply. To troubleshoot the traveling wave tube power supply, disconnect the plug from XV9 (fig. 47). Twist the small metal lockring approximately one-half turn to release the plug, and pull on the traveling wave tube cable connector. Substitute the traveling wave tube (twt) power supply test set (test facilities kit, fig. 150) for traveling wave tube V9. The cable connector on the front of the test set mates with XV9. Interlock switches S3 and S5 (fig. 47) must be energized before power can be applied to t power supply. Perform the voltage and resis ance measurements to locate the defective co ponent within the power supply. Remove t test set and restore the traveling wave tu connection when repairs are completed. controls R11 or R25 were touched duri troubleshooting, refer to paragraph 294*b* f the adjustment procedure.

c. Traveling Wave Tube V9. To check t traveling wave tube proceed as follows:

(1) Remove output cable connector (fig. 46) from traveling wave tu V9. Measure the power output of V using the AN/USM-96A, the 20 db s attenuator (item 5, fig. 150), the 10 attenuator (item 1, fig. 150), a Adapter, N female to TNC male (it 9, fig. 150).

(2) Check for an indication of 1.4 mi watts. If there is no indication, or the indication is low, adjust R11 a R25 (para. 294*b*). If the adjustm procedure does not restore norn operation, replace the traveling wa tube (para. 278*s*).



		FILAMENT TIP	FILAMENT SLEEVE	CATHODE	GRID	PLATE
V1	V	5.8VAC	0V	2.7V	0V	190V
6442	R	0.3	0	680	0	∞
V2	V	5.8VAC	0V	2.0V	0V	190V
6442	R	0.3	0	270	0	∞
V3	V	5.8VAC	0V	2.6V	0V	200V
6442	R	0.3	0	390	0	∞
V4	V	5.8VAC	0V	0.1V	0V	*0V
6442	R	0.3	0	820	0	∞

NOTES

VOLTAGE MEASURED TO GROUND WITH A VTVM, MODULE REMOVED FROM CHASSIS, BACK PLATE REMOVED, AND CONNECTED WITH EXTENDER CABLE

RESISTANCE MEASURED TO GROUND WITH A MULTIMETER, ALL PLUGS DISCONNECTED

3 MEASURE RESISTANCE OF PLATE OF V4 WITH Z1 (PLATE CIRCUIT CAVITY) REMOVED

* VOLTAGE CANNOT BE MEASURED

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Figure 58. Multiplier unit, voltage and resistance diagram.

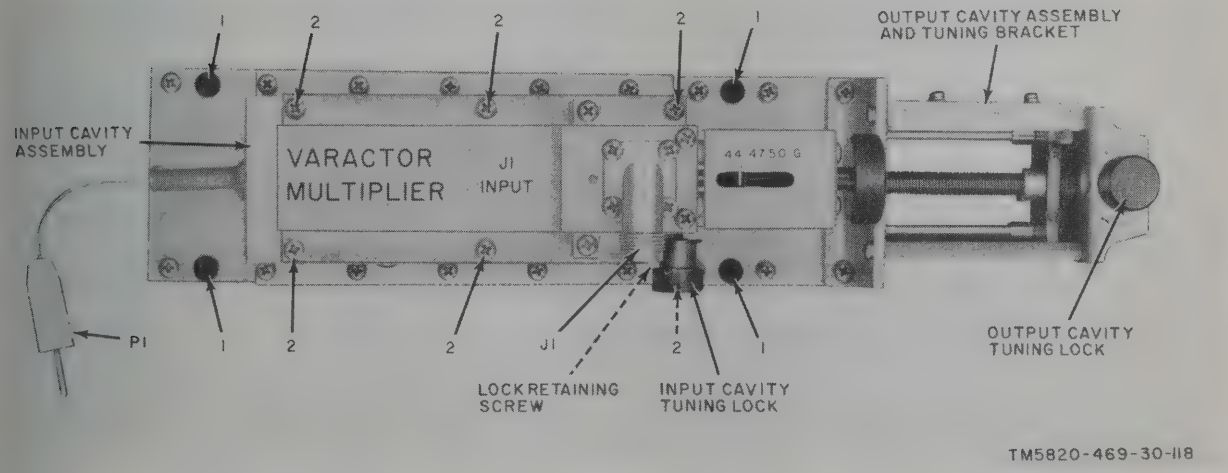


Figure 59. Varactor multiplier, top view.

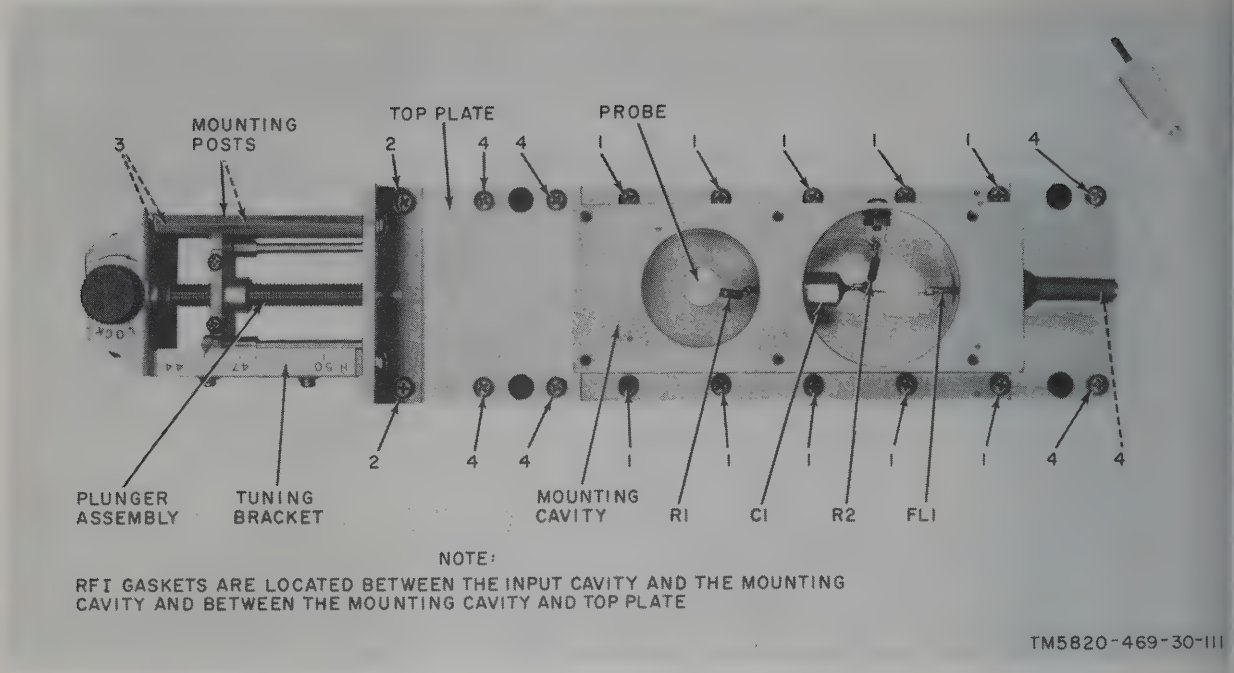


Figure 60. Varactor multiplier, location of internal components (input cavity removed).

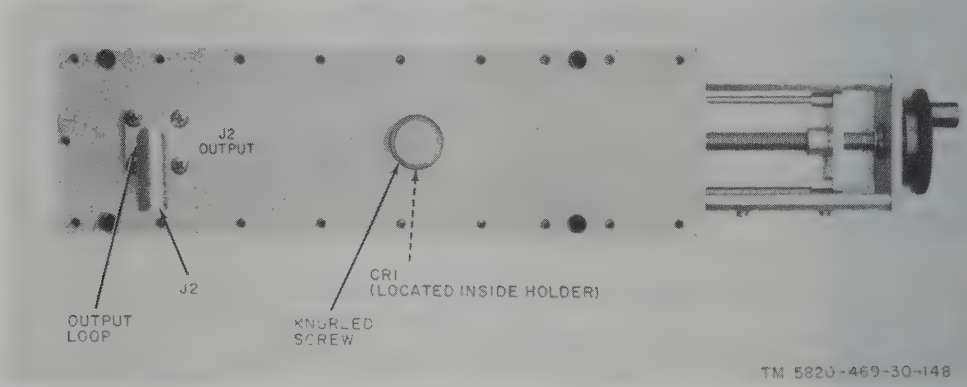


Figure 61. Varactor multiplier, rear view.

231. Troubleshooting 200-Volt Power Supply A1

If satisfactory meter indications on some or all positions of meter function selector switch S4 (fig. 46) are not obtained, or, if the B+ indicator does not light, a defect exists within the 200-volt power supply. Perform the procedures given below to isolate the defect.

Note. The 200-volt power supply used with the transmit converter is identical with the other 200-volt self-contained power supplies used in the modulator-multiplier, the receive converter, synthesizer, multiplexer, etc. Adapt these troubleshooting procedures and the associated illustrations (figs. 62–66) to *all* the 200-v power supplies used in the AN/TRC–80.

a. Check for +200 volts at B+ jack J4 (f 16, TM 11–5820–469–20). If 200 volts is mea ured at this jack, the power supply is functio ing normally. Check for loose connectors lea ing from the 200-volt power supply (fig. 4 If the voltage is low, or if there is no volta at J4, proceed to *b* below. Refer to figures 6 63, and 64 for the component locations.

b. Turn off all power. Remove the five lea from terminals 1 through 5 (fig. 63) and loos

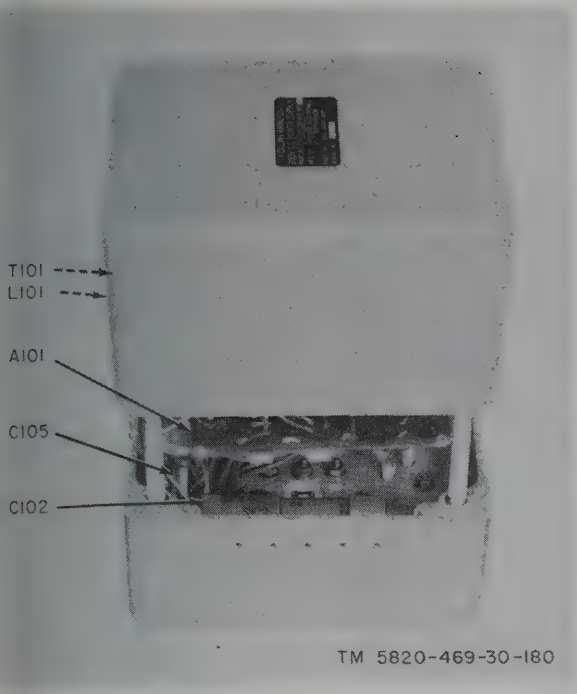


Figure 62. 200-volt power supply, side view.

the four bolts to remove the power supply module.

c. The 200-volt power supply test set (test facilities kit, fig. 150) contains an extension cord which is plugged into the front panel. Connect the numbered spade lugs on this cord to the corresponding terminals (1 through 5) on the 200-volt power supply module. Then, plug the test set cord into the test set. To apply power to the power supply module, turn the POWER switch on the test set to ON.

d. Connect an ME–26/U to the 200 VDC and ground test points on the test set. Using the test set switches, check the full-load, half-load, and no-load voltage of the power supply module. If the voltage remains constant, the power supply is functioning normally. If voltage variations exceed 5 percent of the rated voltage, proceed to *e* below.

e. Refer to figures 65 and 66 and perform the voltage and resistant measurements with

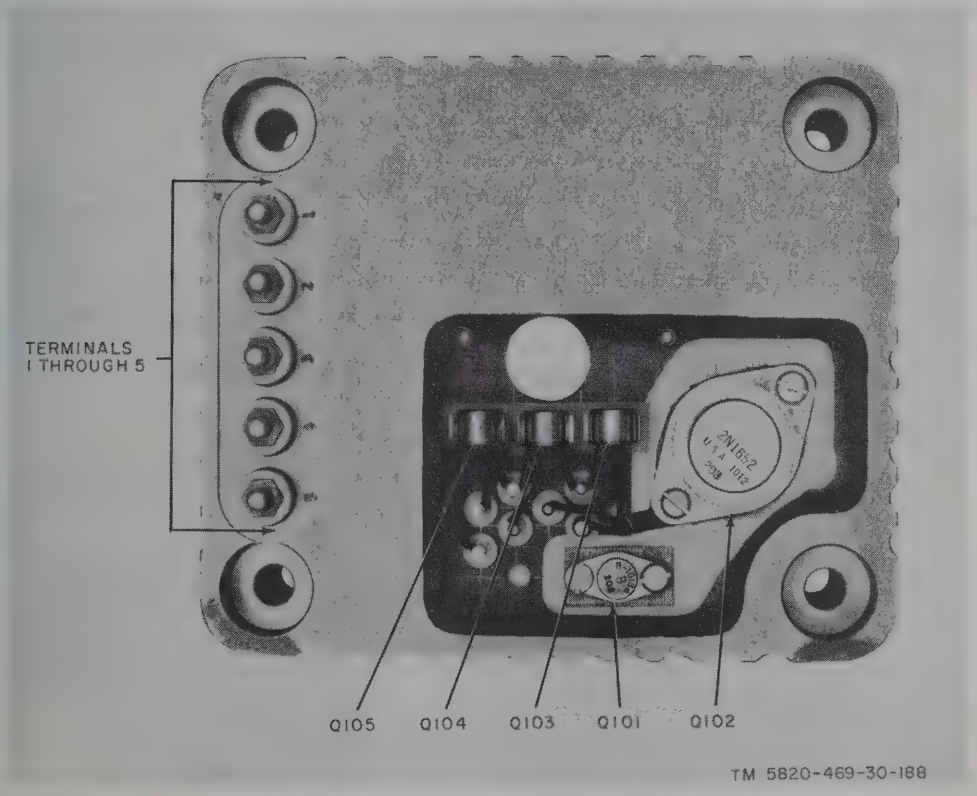


Figure 63. 200-volt power supply, bottom view.

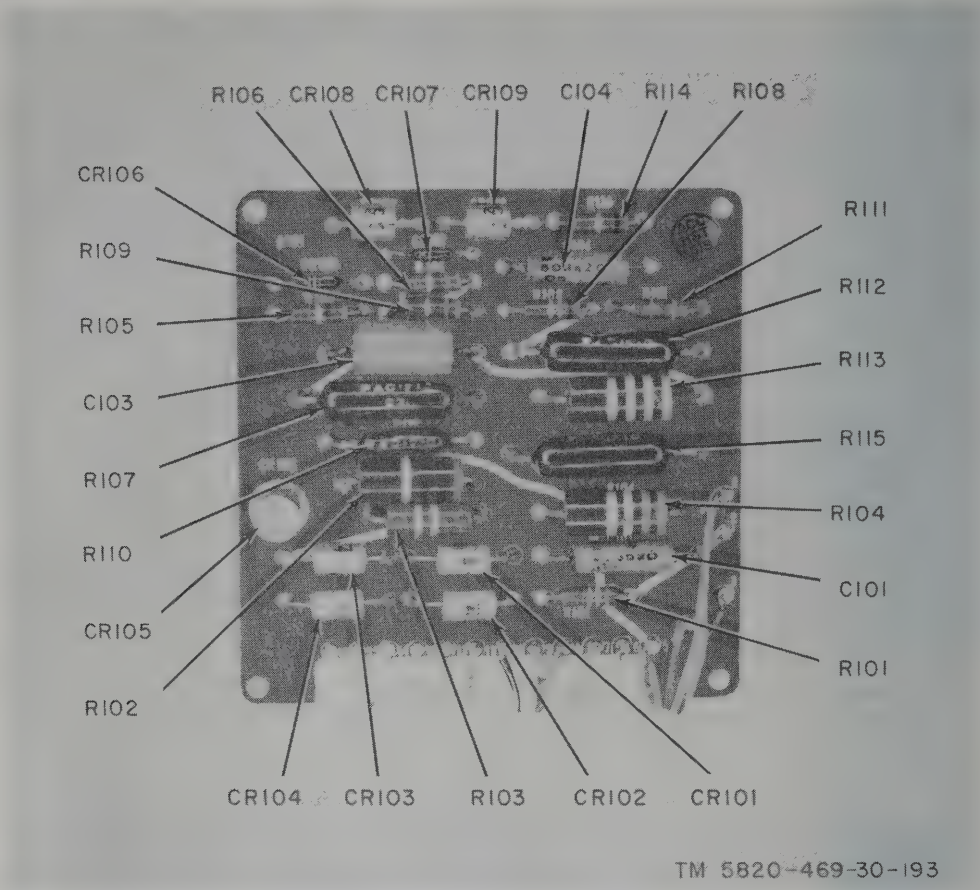


Figure 64. 200-volt power supply, component board A101.

the ME–26/U. Measure the ripple voltage at terminal 4 with an ME–30/U. If the ripple voltage exceeds 50 millivolts, check for a defective filter component. Approximately 315 volts root mean square (rms) should be measured across the secondary of T101. Output voltage from the bridge rectifier (measured across C101, fig. 64) should be approximately 305 volts dc with no load and 265 volts dc with a load. If a defective bridge rectifier diode is located, replace both diodes within the pair (CR101, CR104; and CR102, CR103). If there is a loss of regulation or no output at all, series regulator transistor Q102 should be checked. If a defect is localized to the transistorized voltage regulator board, higher echelon repair is required.

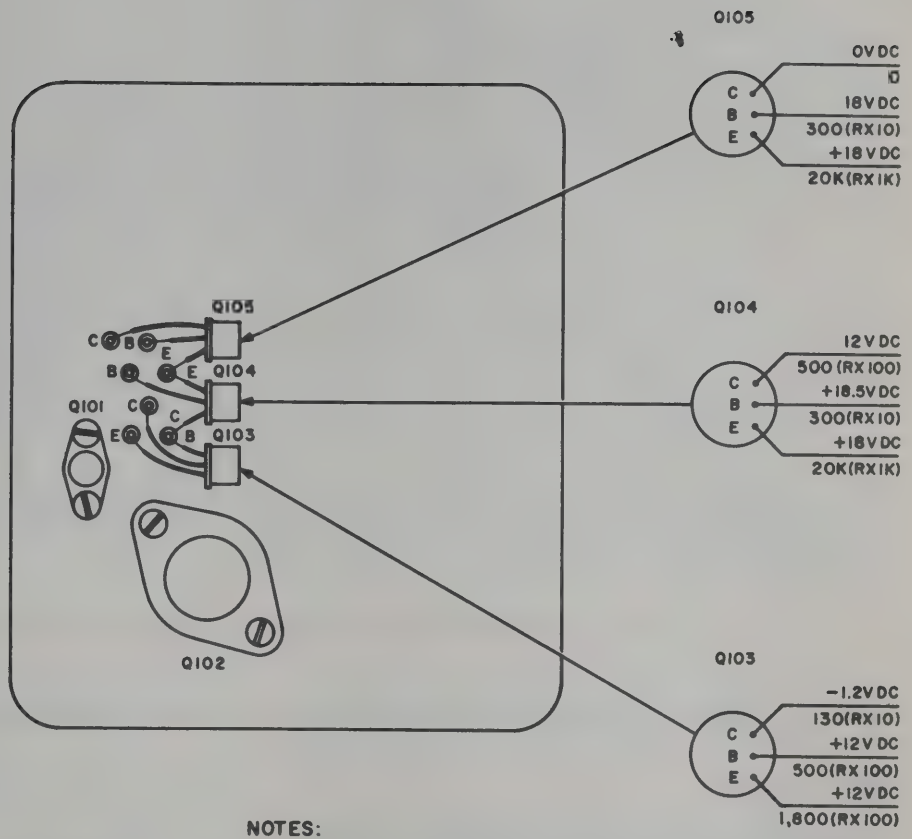
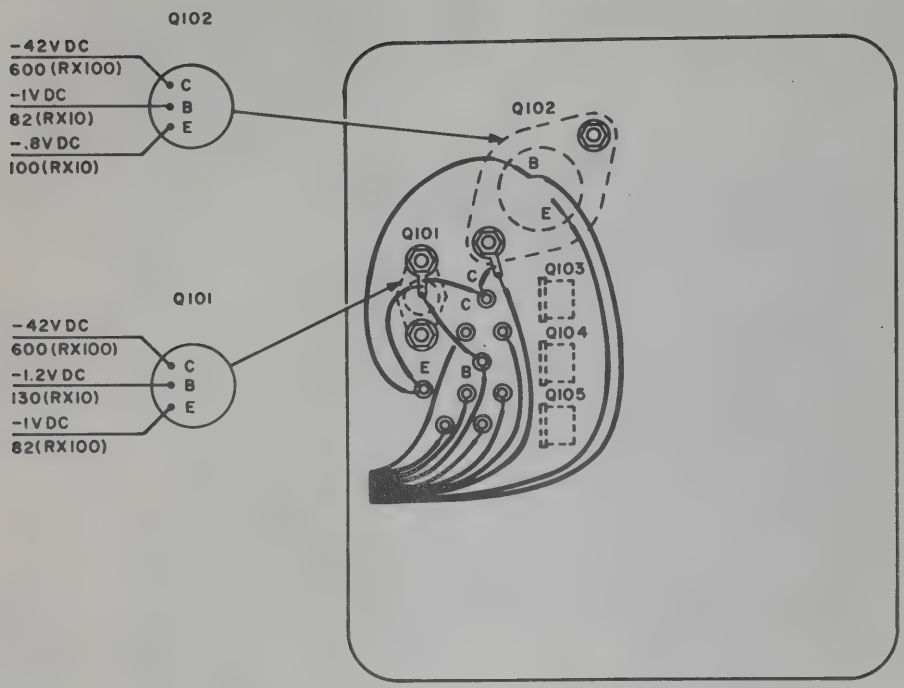


Figure 65. 200-volt power supply, bottom view, voltage and resistance diagram.



NOTES:

1. ELECTRONIC MULTIMETER ME-26/U USED FOR ALL MEASUREMENTS
2. ALL MEASUREMENTS WITH RESPECT TO GROUND, TERMINAL NO. 5
3. METER RANGE INDICATED ON RESISTANCE MEASUREMENT
4. VOLTAGES TAKEN WITH 250MA LOAD

TM5820-469-30-72

Figure 66. 200-volt power supply, top view, voltage and resistance diagram.

Section IV. MODULATOR-MULTIPLIER TROUBLESHOOTING PROCEDURES

232. General

For troubleshooting purposes, the modulator-multiplier should be divided into its four functional sections—the 200-volt dc power, the order-wire input circuit, the multiple input circuit, and the frequency multiplier section. Detailed functions of these circuits are described in paragraphs 26 through 48. The 200-volt self-contained power supply is identical with the power supply used in the transmit converter. Adapt the troubleshooting procedures given in paragraph 231 to troubleshoot this power supply. When this equipment is used as part of the Pershing Weapons System, a failure within the multiplex input circuits will not affect normal operation because the modulating signal is applied through the order-wire circuit (para. 27). The component locations are illustrated in figures 67 through 70. Figu 187 is the voltage and resistance diagram, ar figure 154 is the complete schematic diagra This chassis contains no interlock switches ar does not require forced-air cooling during t repair procedures.

233. Modulator-Multiplier Test Setup

Set the modulator-multiplier on a servi bench and apply 115-volt ac primary power terminals 1 and 2 of TB1 (fig. 68). Remo the backplate to provide access to componen located inside the chassis. The test equipme required to troubleshoot the modulator-mult plier is as follows:

a. Radio Frequency Power Test Set AN USM-96A.

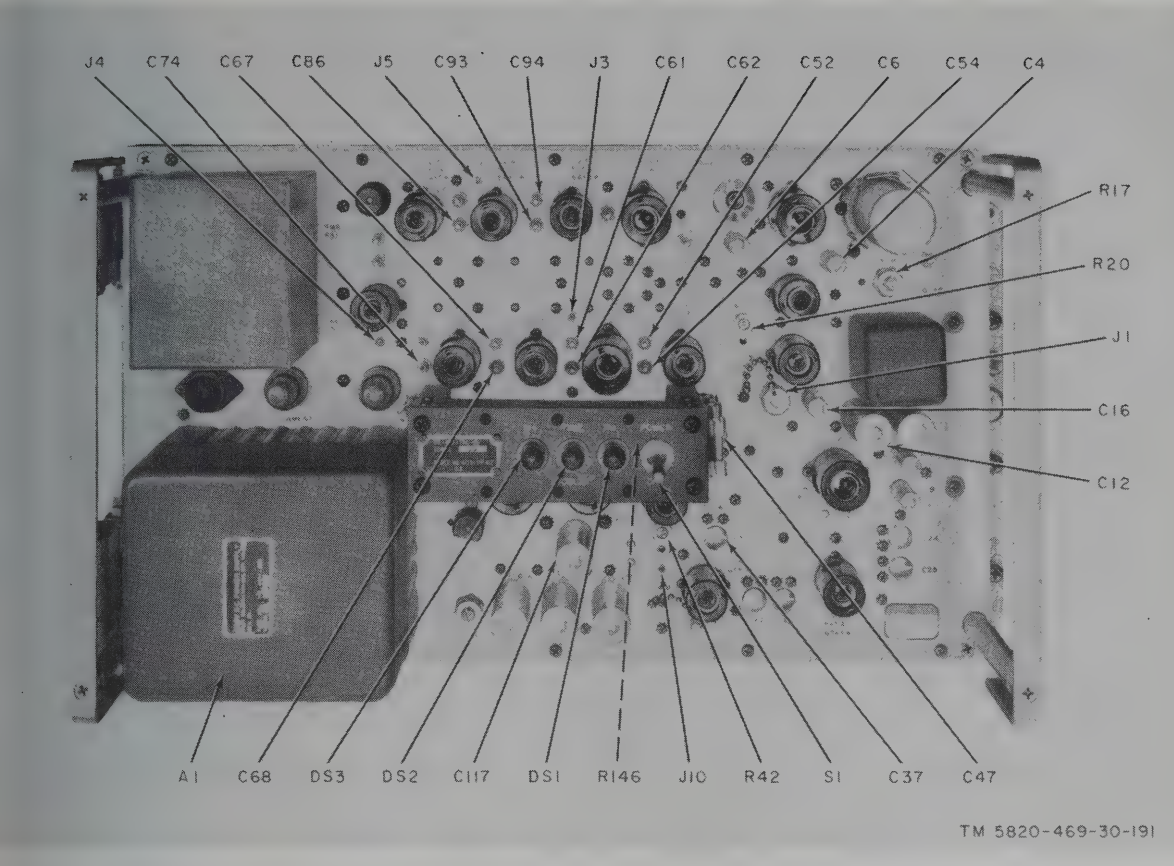


Figure 67. Modulator-Multiplier MD–465/TRC–80, front view, dust cover removed (part 1 of 2).

b. Voltmeter, Electronics ME–30B/U.

c. Multimeter ME–26B/U.

d. Meter, Modulation ME–57/U.

e. Signal Generator SG–71/FCC.

f. Test facilities kit for AN/TRC–80 (para. 5) (fig. 150).

4. Troubleshooting Frequency Multiplier Stages (V8 through V16)

Caution: **Do not attempt the power output measurement without using the attenuator and adapters listed in *a* below. Equipment will be damaged if this precaution is not observed.**

a. Connect the modulator-multiplier as directed in paragraph 233. Use the AN/USM–96A to measure the power available at 70-mc output jack J6 (fig. 70). The 20-db coaxial attenuator (item 3, fig. 150) must be inserted between the AN/USM–96A and jack J6, by use of Adapter, N female to BNC male (item 14, fig. 150) and Adapter, BNC tee (item 8, fig. 150).

b. If the power level at J6 is at least 200 milliwatts, the multiplier stages (V8 through V16) are probably functioning normally. Check the modulating, multiplex, and order-wire input circuits (paras. 235 and 236). If the measurement at J6 is below 200 milliwatts, use an ME–30B/U to check the input voltage applied to the frequency multiplier chain at J2 (fig. 67). The voltage at J2 should be approximately 400 to 500 millivolts. If this voltage is missing, no input signal from the multiplex phase modulator (V6 and V7) is being applied to V8. Refer to paragraph 236. If the voltage at J2 is normal, use the ac probe on the ME–26B/U to measure the rms ac voltages at test points J3, J4, and J5 (fig. 67). The voltages should progress from 0.5 to 1.5 volts ac. If the voltage is missing at one or more of these test points,

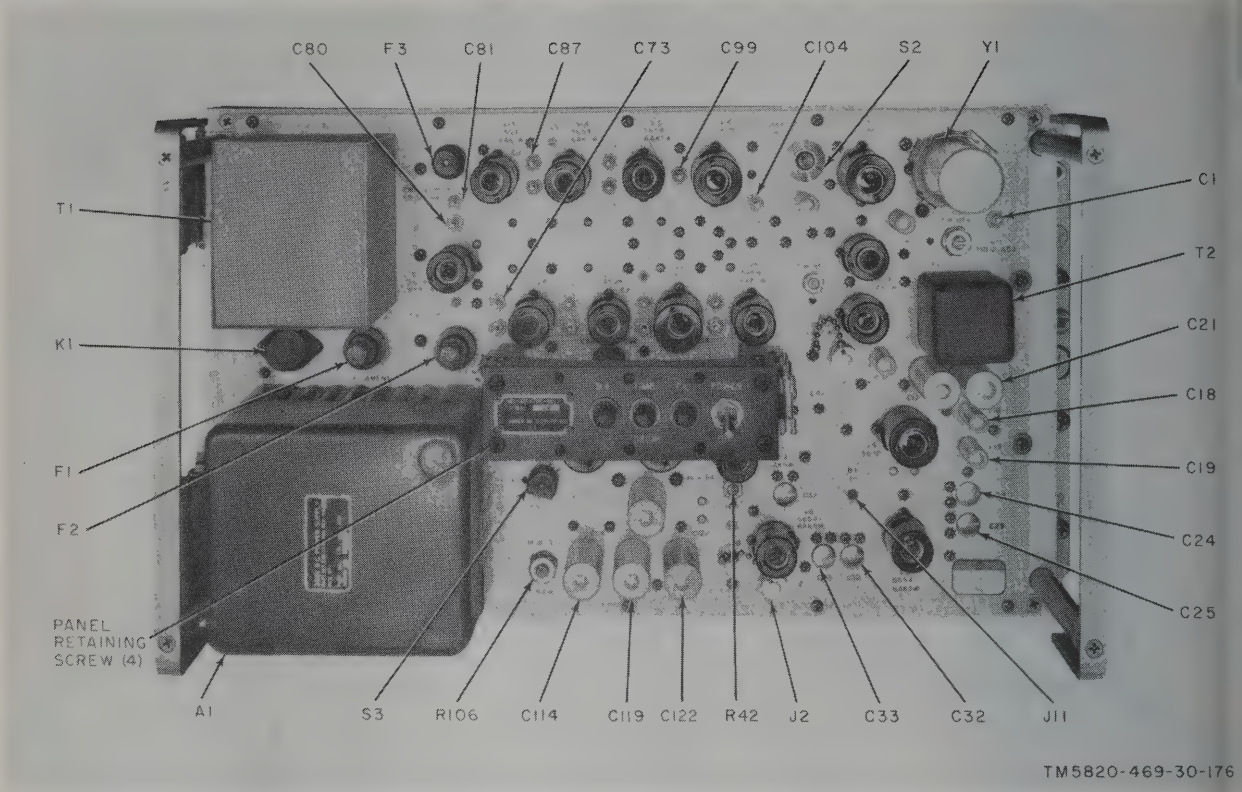


Figure 67. Modulator-Multiplier MD–465/TRC–80, front view, dust cover removed (part 2 of 2).

use the schematic diagram (fig. 154) to isolate the stage or stages that are monitored by the test points. Perform the voltage and resistance measurements (fig. 187) to locate the defective component.

235. Troubleshooting Order-Wire Phase-Modulator Section

When audio signals applied to order-wire input jack J8 ((2), fig. 68) do not modulate the carrier, and when the procedures given in paragraph 234 indicate that the frequency multiplier chain (V8 through V16) is functioning normally, perform the following check to isolate trouble to the order-wire input and order-wire phase-modulator circuit.

Note. Connect the modulator-multiplier as specified in paragraph 233.

a. Set the SG–71/FCC to produce a 1,000-cps signal. Apply the 1,000-cps signal between pins A and C of order-wire input jack J8, using the modulator-multiplier test cable extender (ite 29, test facilities kit, fig. 150). Monitor th input level with an ME–30B/U and adjust th SG–71/FCC output to produce a level of —1 dbm.

b. Connect the ME–30B/U to test jack J (fig. 67) and depress CARRIER SWITCH S The ME–30B/U should indicate approximatel —18.5 dbm (90 millivolts). It may be nece sary to slightly readjust OW BAL control R2 (Slight variations in the null reading do n indicate a malfunction.)

c. Release CARRIER SWITCH S2. Th ME–30B/U measurement at J1 should rise t approximately 2 to 4 volts rms. If the measur ment in *b* above was normal (indicating tha the order-wire input circuit and the phas modulator circuit were functioning correctly and the measurement made in this step is no the defect is located in crystal Y1 (fig. 67) oscillator-cathode follower V1, or in the assoc

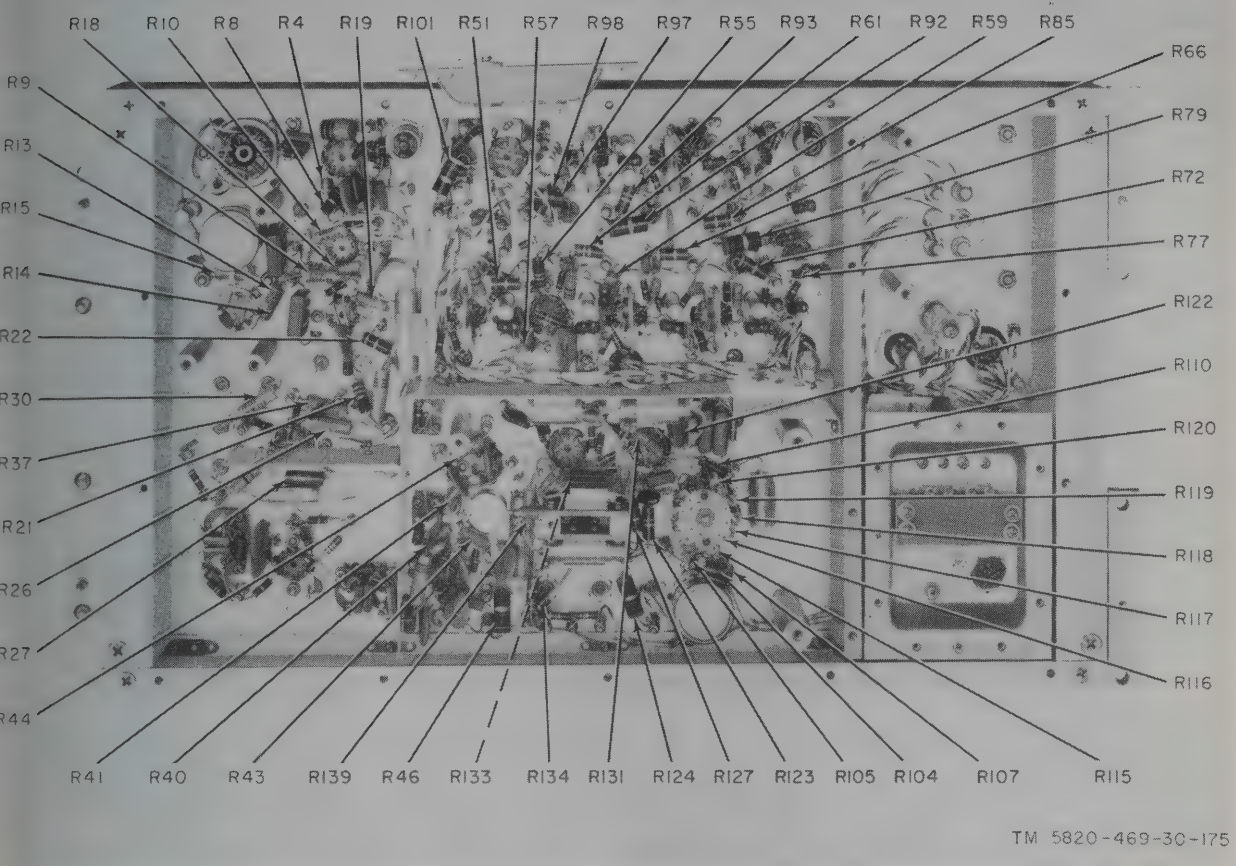


Figure 68. Modulator-Multiplier MD–465/TRC–80, rear view, dust cover removed (part 1 of three).

ed circuit components. Refer to figure 187 d perform the voltage and resistance meas- ements to isolate the defective part.

d. Refer to TM 11–6625–400–12 and adjust eter, Modulation ME–57/U for measurement a 70-mc carrier signal with a 9-kc deviation. nnect the ME–57/U to J6 (fig. 70) and check r a 9-kc deviation. If necessary, readjust V DEV control R17 to obtain this deviation.

e. If the frequency deviation measurement above) is not satisfactory but the RF levels jacks J1 through J6 are normal, check for a al loss of audio input or a component failure tween J8 and the input to modulators V2 and 3. Refer to figure 187 for the voltage and sistance data.

236. Troubleshooting Multiplex Phase-Modulator Input Circuits (AF and RF Inputs)

Notes.

1. When the AN/TRC–80 is used as part of the Pershing Weapons System, the multiplex input circuit (J9, V17, V18) is not used and multiplex phase modulator V6 and V7 function as RF amplifiers. Refer to paragraph 34 through 37 for additional functional details.

2. MUX DEV control R106 should always be turned fully counterclockwise (to reduce the possibility of stray noise entering the system) when the multiplex input signals are not applied through MUX INPUT jack J9 (fig. 24, TM 11–5820–469–20).

a. When the modulator-multiplier functions normally with the audio input applied through

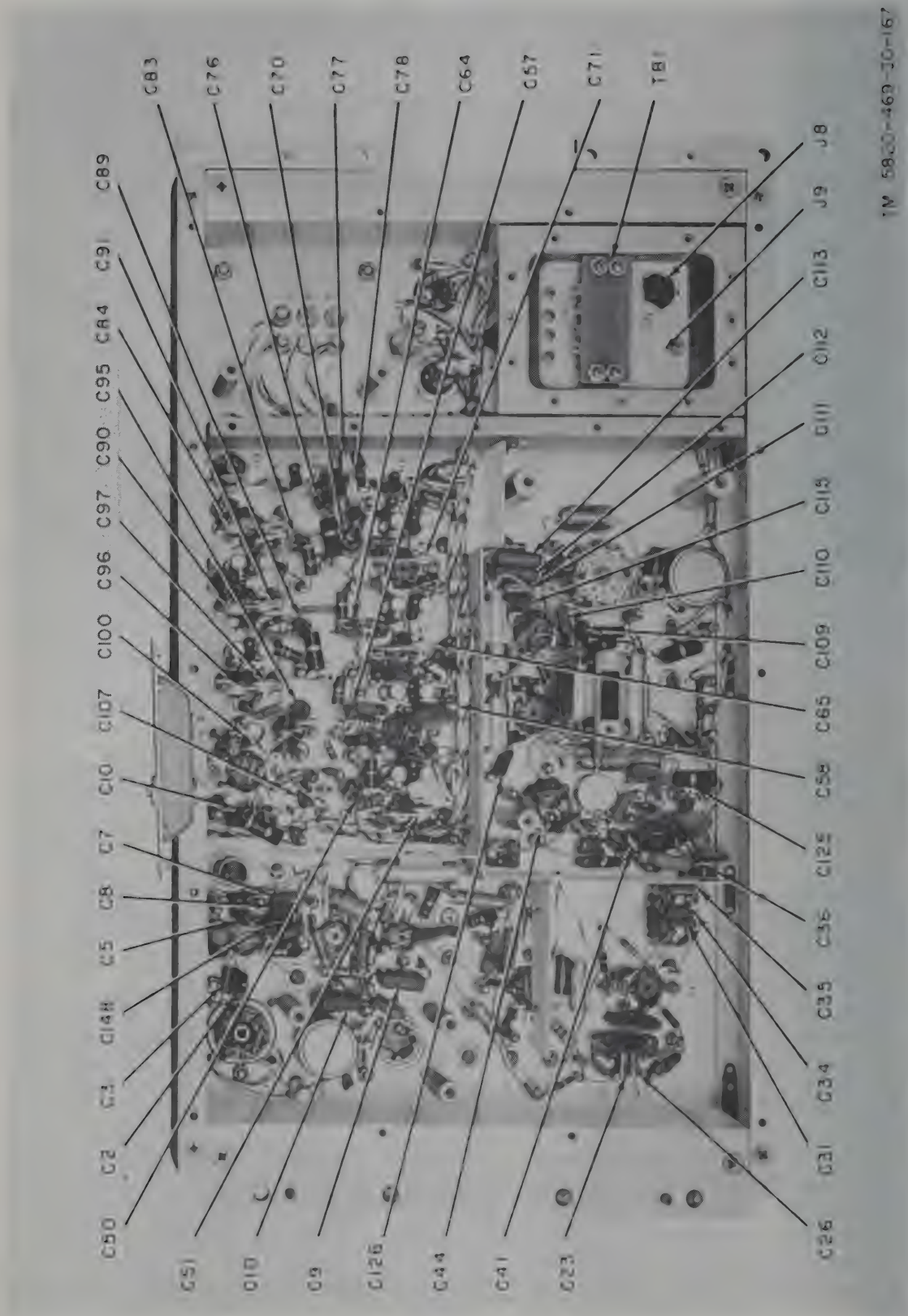


Figure 68. Modulator-Multiplier MD-465/TRC-80, rear view, dust cover removed (part 2 of three).

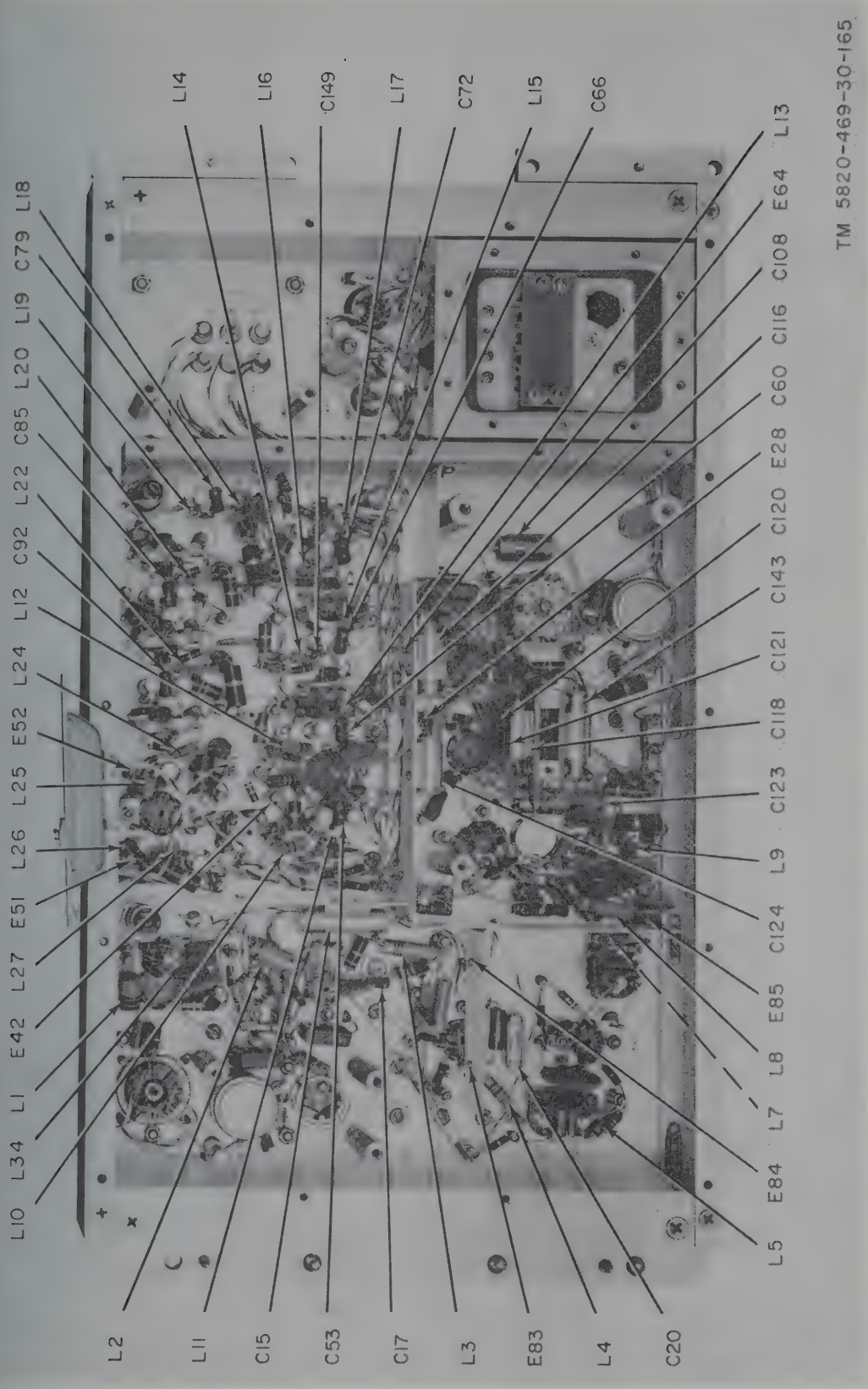


Figure 68. Modulator-Multiplier MD-465/TRC-80, rear view, dust cover removed (part 3 of 3).

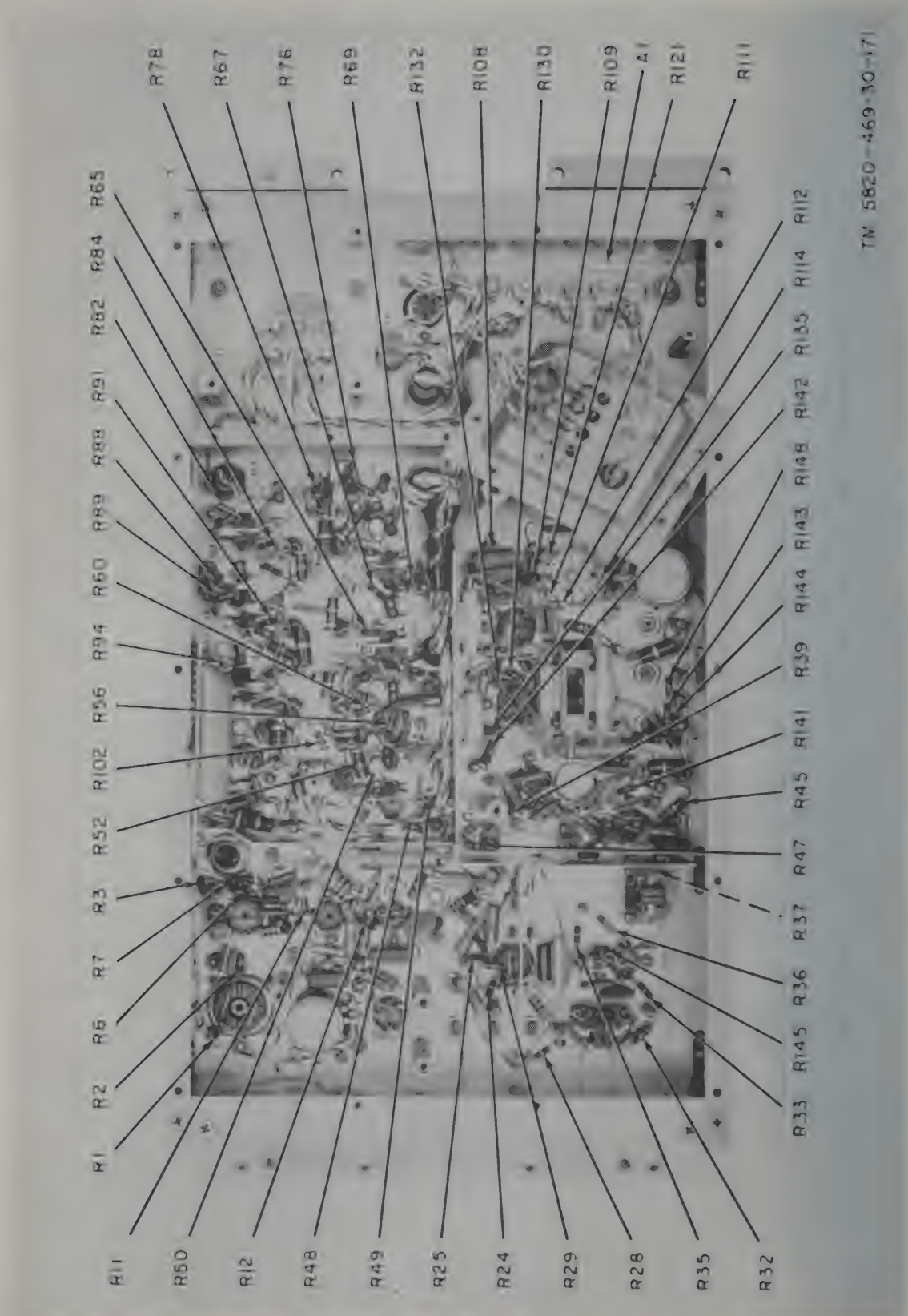


Figure 69. Modulator-Multiplier MD-465/TRC-80, rear view, dust cover removed and signal input board TB1 components exposed (part 1 of 3).

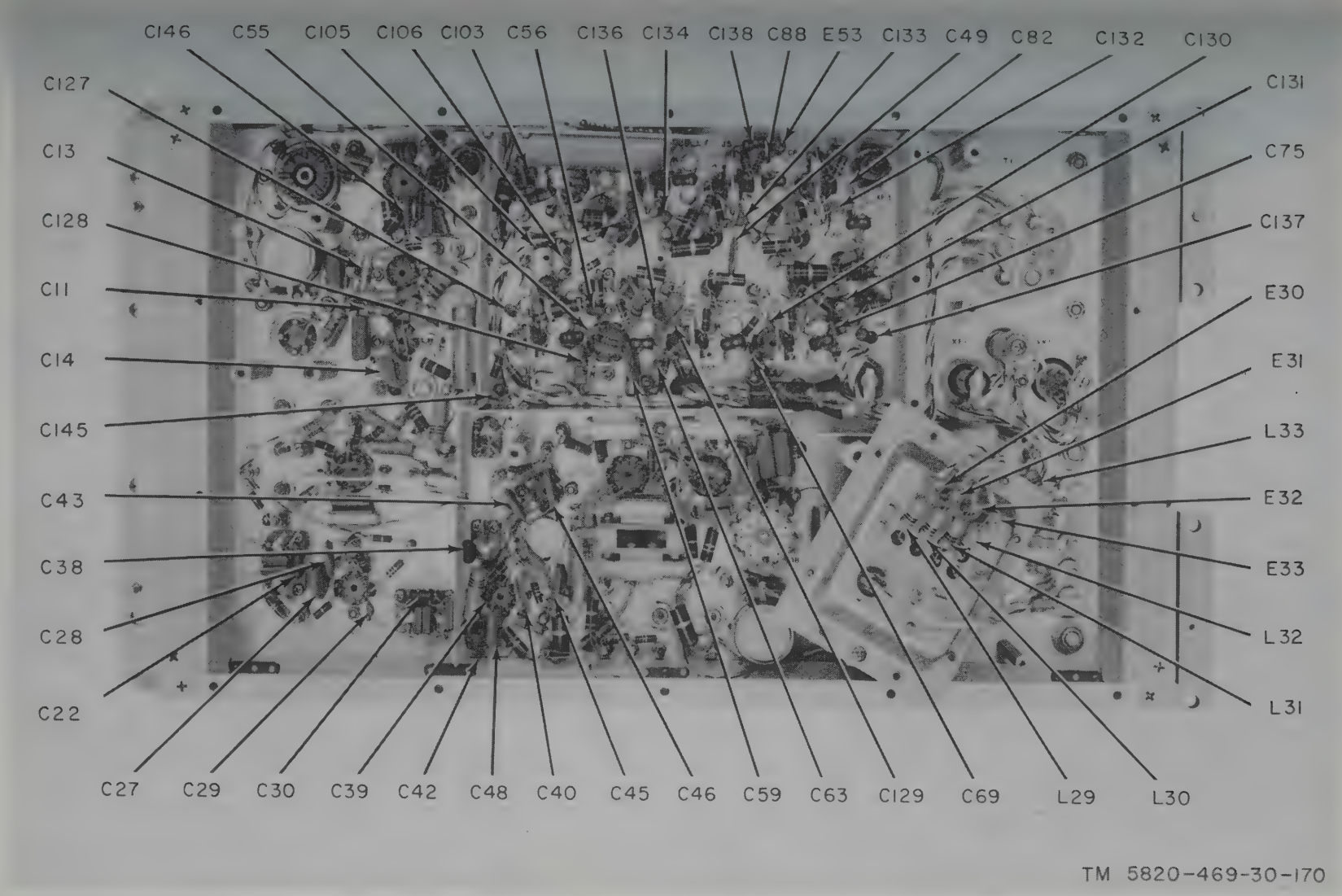


Figure 69. Modulator-Multiplier MD–645/TRC–80, rear view, dust cover removed and signal input board TB1 components exposed (part 2 of 3).

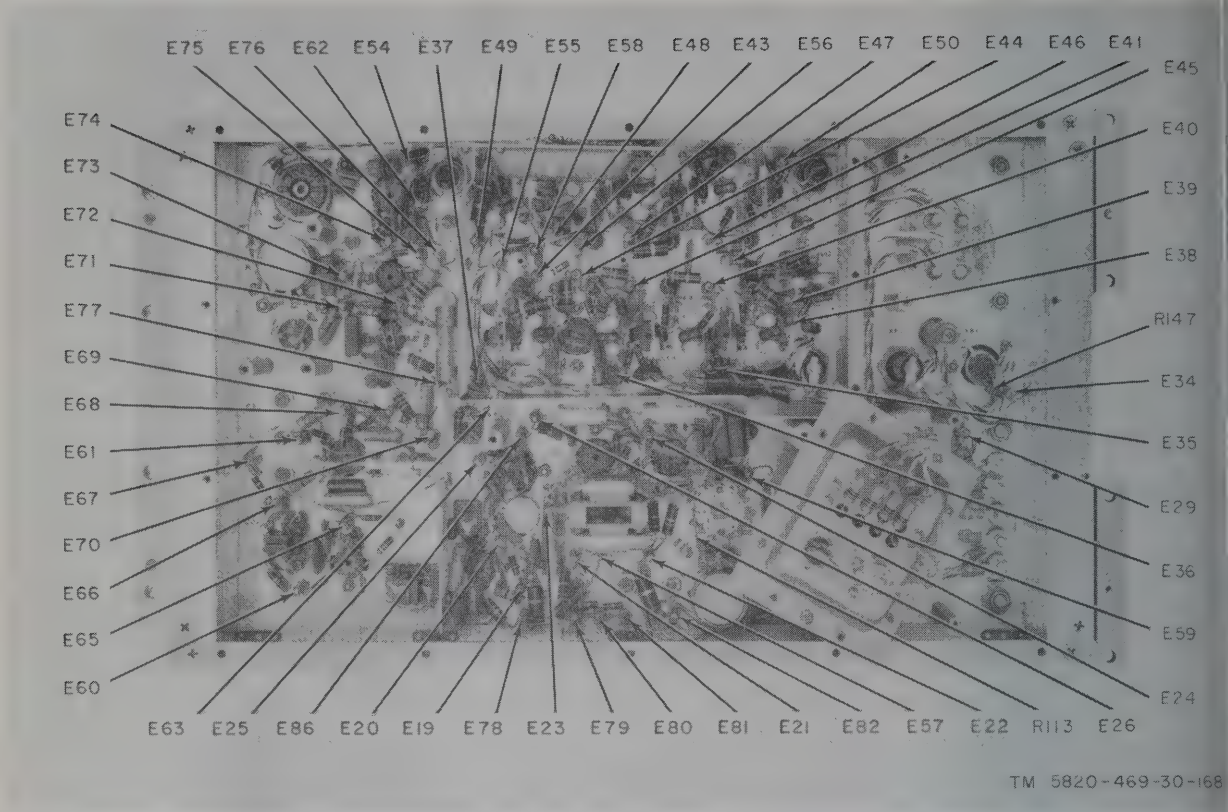


Figure 69. Modulator-Multiplier MD–465/TRC–80, rear view, dust cover removed and signal input board TB1 components exposed (part 3 of 3).

order-wire input jack J8 but does not function correctly when mux signals are applied to MUX INPUT jack J9, perform the following test:

(1) Set the SG–71/FCC to produce a 25-kc signal.

(2) Apply the 25-kc signal to MUX INPUT jack J9.

(3) Measure the input voltage with the ME–30B/U and adjust the input signal for a —11-dbm level.

(4) Position MICRO SEC EMPHASIS switch S3 to 5.0 microseconds.

(5) Connect an ME–57/U to J6 (fig. 70) to verify that the 70-mc output is being modulated.

(6) Adjust MUX DEV control R106 for the desired 9-kc deviation on the ME–57/U.

(7) If the desired indication is not ob tained, refer to the complete schemat diagram (fig. 154) and perform th voltage and resistance measuremen on the mux input circuit and V17 an V18 (fig. 187).

b. When the modulator-multiplier will no pass modulating signals from either J8 or J and the frequency multiplier stages are opera ing normally (para. 234), the defect is probab located between oscillator V1B and multiple phase modulator V6 and V7. Perform the fo lowing test to isolate the trouble.

(1) To isolate the trouble between osci lator V1 and the output of order-wi phase modulator V3 and V4, perfor the procedure given in paragrap 235*b* and *c*.

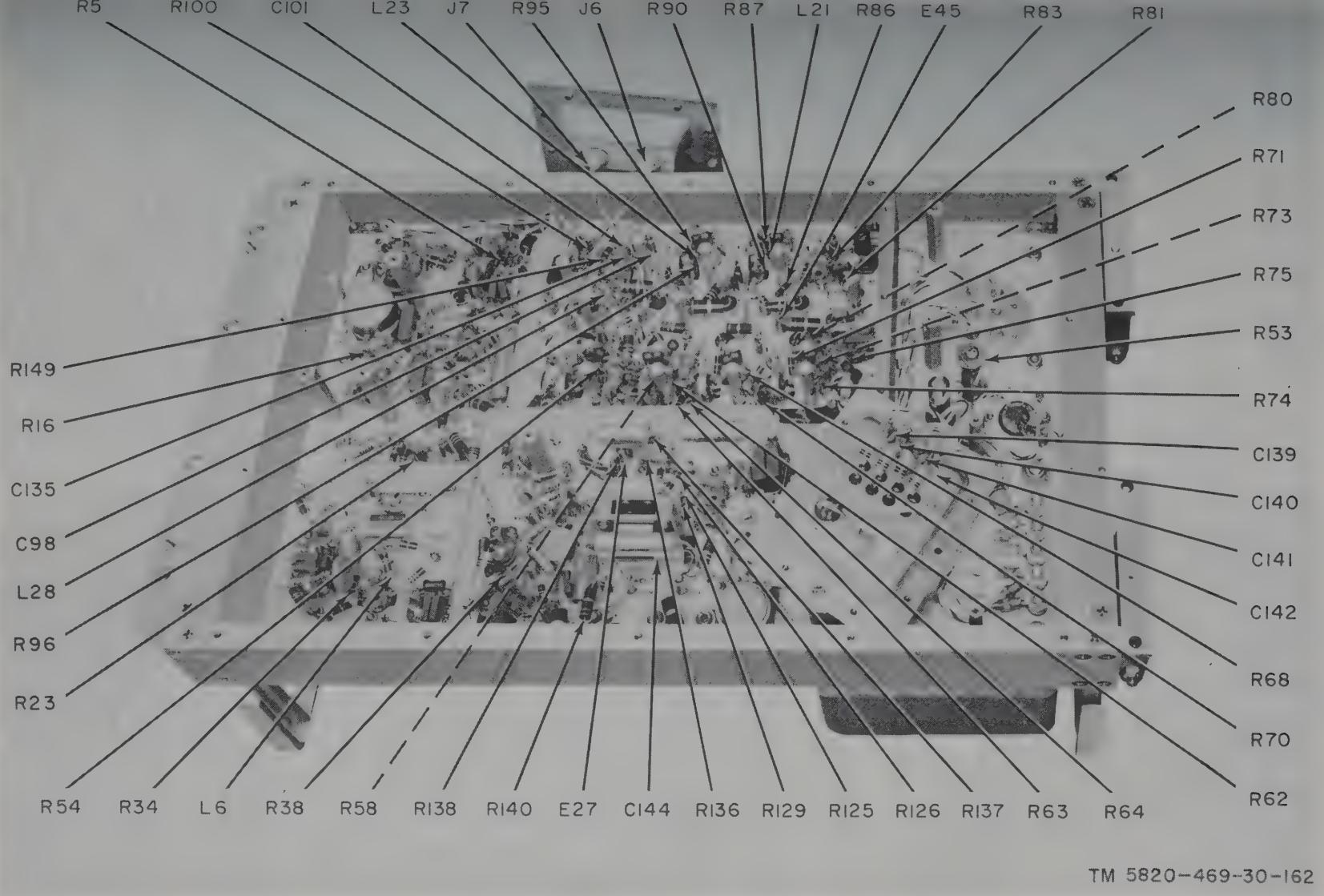


Figure 70. Modulator-Multiplier MD-465/TRC-80, rear oblique view.

(2) If the correct signal voltage is measured at J1, connect the ME–30B/U to J2 and check for approximately 450 millivolts. If this voltage is missing, perform the voltage and resista measurements on V4 through V7 isolate the defective component.

CHAPTER 18

RECEIVE GROUP TROUBLESHOOTING

Section I. LOCALIZING TROUBLES

7. Localizing Procedures

a. General. Radio Receiver Group OA–31/TRC–80 (receive group) consists of mplifier Converter AM–3302/TRC–80 (re-ive converter), Power Supply PP–3314/RC–80 (receive converter power supply), In-rmediate Frequency Amplifier AM–3328/RC–80 (IF amplifier), and Power Supply P–3313/TRC–80 (IF amplifier power supply). nce the receiving equipment in the AN/TRC– consists of two completely independent re-ve groups, failure in one of the receive oups generally will not disrupt communica-n but will limit the function of the AN/RC–80 to nondiversity operation. By per-rming the tuning procedures (TM 11–5820–9–10) for each receive group, a defect can traced to one of the receive groups and ntatively located to a specific chassis. The calization procedures, and illustrations of ble connectors, terminal boards, coaxial ble interconnecting diagrams, and tube and assis locations are contained in TM 11–5820–9–20.

b. Initial Procedures. When the trouble mptom is not known, refer to paragraphs and 64 of TM 11–5820–469–10 and attempt tune the receive group. When a defect is ob-rved, refer to the receiver trouble sectionali-tion charts (paras. 18 and 19, TM 11–5820–9–20) to sectionalize the trouble to a major it. From the sectionalizing procedures, refer the localizing procedures given in para-aphs 30, 31, and 32 of TM 11–5820–469–20. e localizing procedures in the organizational aintenance manual will normally localize de-cts down to a subchassis within the receive nverter or the IF amplifier chassis. Before removing the receive converter or the IF amplifier chassis and their associated power supplies from the shelter for service in the maintenance van, perform the additional localization procedures described in paragraphs 238 and 239.

238. Receive Converter Localizing Procedures

When the troubleshooting procedures at the organizational maintenance level do not restore normal operation, perform the procedures in this paragraph *before* removing the receive converter from the shelter for detailed troubleshooting. The tuning meter on the meter panel of the receive converter provides a means of trouble localization. Perform the complete receive converter tuning procedure as outlined in TM 11–5820–469–10 and observe the tuning meter. Note that the receive converter will *not* tune correctly unless the frequency synthesizer input is normal. If the frequency synthesizer input is suspected, temporarily substitute synthesizers by interchanging the output cables at J604 (fig. 27, TM 11–5820–469–20). If synthesizer substitution has no effect on the receive converter tuning, proceed to *a* below.

a. Receive Converter Performance Check. If this test is satisfactory, the defect is not located in the receive converter. If the test is not satisfactory, refer to *b* below.

(1) Recheck the tuning; use the procedure outlined in TM 11–5820–469–10. With no input signal, adjust IF amplifier RCVR GAIN control R4 (fig. 97) (bandwidth control module) to obtain an indication of 6 on meter M1 (fig. 111) (8-mc IF amplifier No. 2 mod-

ule) with meter switch S1 at RCVR GAIN 6 position.

(2) Place the receive converter METER FUNCTION SELECTOR switch in the J-TUN. DET position.

(3) Adjust TUN. DET METER ADJUST control R12 (on the receive converter chassis) fully clockwise.

(4) Depress TUNE-UP SIGNAL switch S2. A full-scale deflection of the receive converter front panel meter indicates proper operation.

b. Trouble Localization Chart. During no mal operation, XTAL CURRENT ADJUS control R10 is usually set to the midrange pos tion. Since this adjustment may vary som what, the typical meter indications in this cha are made *with this control set at the maximu clockwise position.* At this setting, the a amplifier is disabled. After reaching the XTAL CUR position given in the chart belo readjust this control for a SET POINT or mi scale indication. All the controls that are a justed in the *Procedure* column of the chart a illustrated in figure 53, of TM 11–5820–469–1

Step	Meter function selector switch	Procedure	Meter normal indication	Corrective measures
Note. The crystal oscillator in the oscillator unit is used only when the AN/TRC–80 is not part of the Pershing Weapons System. Wh the AN/TRC–80 is used as part of the Pershing Weapons System, set S1 to EXT and omit steps 1 and 2.				
1	A	Place S1 (on oscillator unit) at INT. Tune C1 on oscillator unit for maximum meter indication.	45	Check Y1 and V1 (para. 242)
2	NULL A	Tune C1 for best possible null.	10	Same as above.
3	B	Tune C2, C3, and C4 on oscillator unit for maximum.	65	Check stages V2, V3, and V4 oscillator unit (para. 242).
4	C	Tune C3 and C6 on multiplier unit for maximum.	90	Check stage V1 in multipli unit (para. 243).
5	D	Tune C14 on multiplier unit for maximum.	95	Check stage V2 in multipli unit (para. 243).
6	E	Tune C22 on multiplier unit for maximum.	100	Check stage V3 in multipli unit (para. 243).
7	F	Adjust tuning control F on the multiplier unit for maximum.	50	Check stage V4 in multipli unit (para. 243).
8	G	Adjust tuning control G on varactor multiplier for maximum.	75	Check varactor multiplier a sembly A3 (para. 244).
9	H-XTAL CUR	Adjust tuning control H for maximum. Reduce XTAL CURRENT ADJUST control for desired SET POINT indication.	Full scale; then readjust to SET POINT	Check varactor multiplier (pa 244), mixer crystals CR1 a CR2 (para. 246), and recei converter power supply cho per amplifier (paras. 249, 2 and 251).
10	J-TUN. DET	Depress TUNE-UP SIGNAL switch S2. Tune preselector and phase shifter for maximum. Adjust TUN. DET METER ADJUST control as required to keep meter on scale.	Full scale	Check mixer crystals CR1 a CR2 (para. 246), 70-mc tu up oscillator (para. 245), preamplifier (para. 248), a IF amplifier through V4 8-mc IF amplifier No. module (para. 255*e*).
11	AGC	None.	80	Check receive converter pow supply chopper amplif (para. 249).
12	70 MC	Depress TUNE-UP SIGNAL switch S2.	45	Check tuneup oscillator (pa 245).

Meter function selector switch	Procedure	Meter normal indication	Corrective measures
B+	None.	50	Check receive converter power supply (para. 249), rack cables, and connectors.
RECEIVE SIG DET	No signal (background noise). Depress TUNE-UP SIGNAL switch S2.	85	IF amplifier combiner-control voltage diode rectifiers CR1 through CR8 (para. 258).

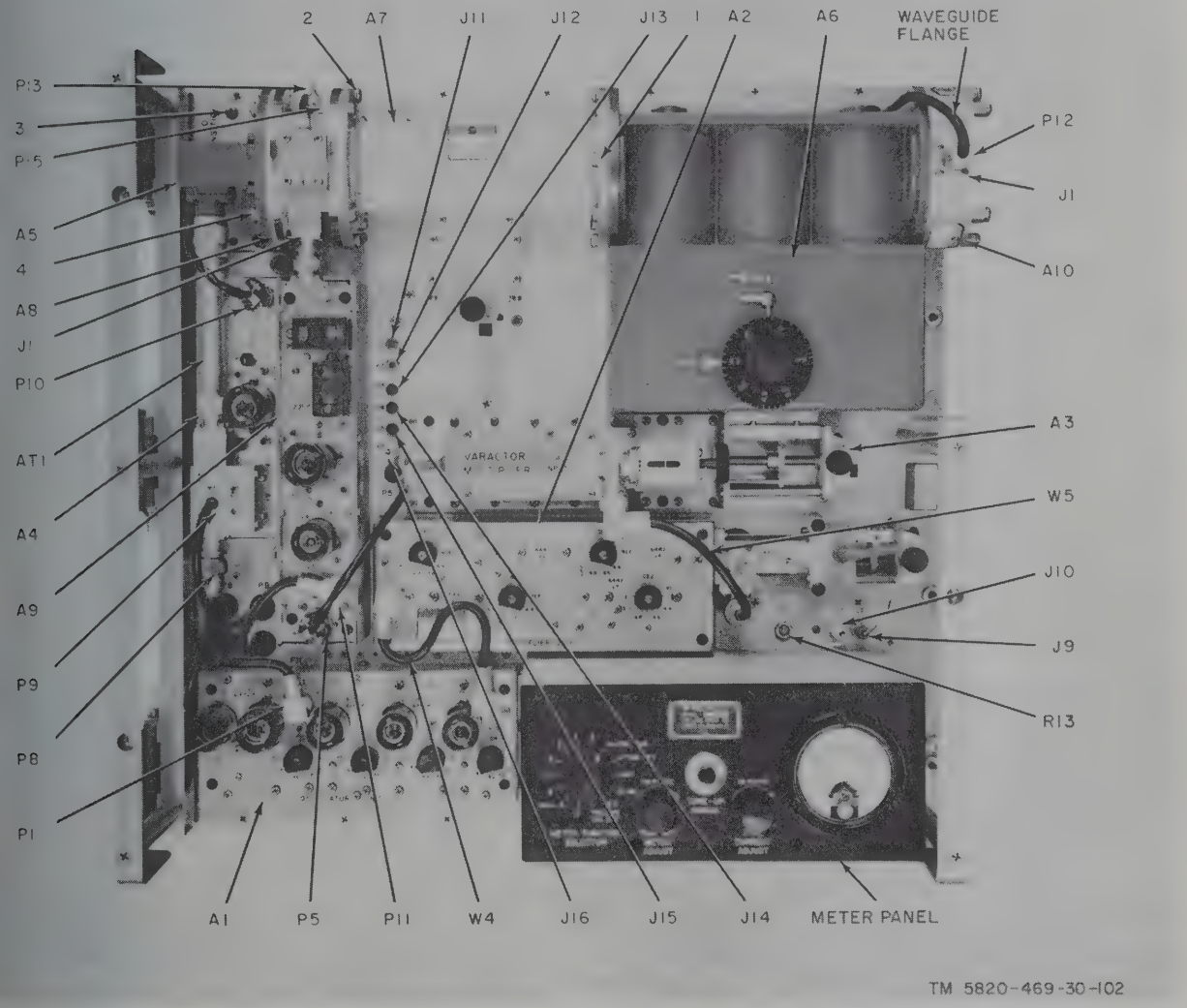


Figure 71. Receive converter, front view.

9. IF Amplifier Localizing Procedure

a. *IF Amplifier Power Supply* (fig. 74). The amplifier power supply consists of a 6.3-ac ment source, a 6.3-dc filament source, and three 200-volt dc power supplies. The following localizing procedures assume that all fuses have been checked at the organizational level. The checks below will localize trouble to one of

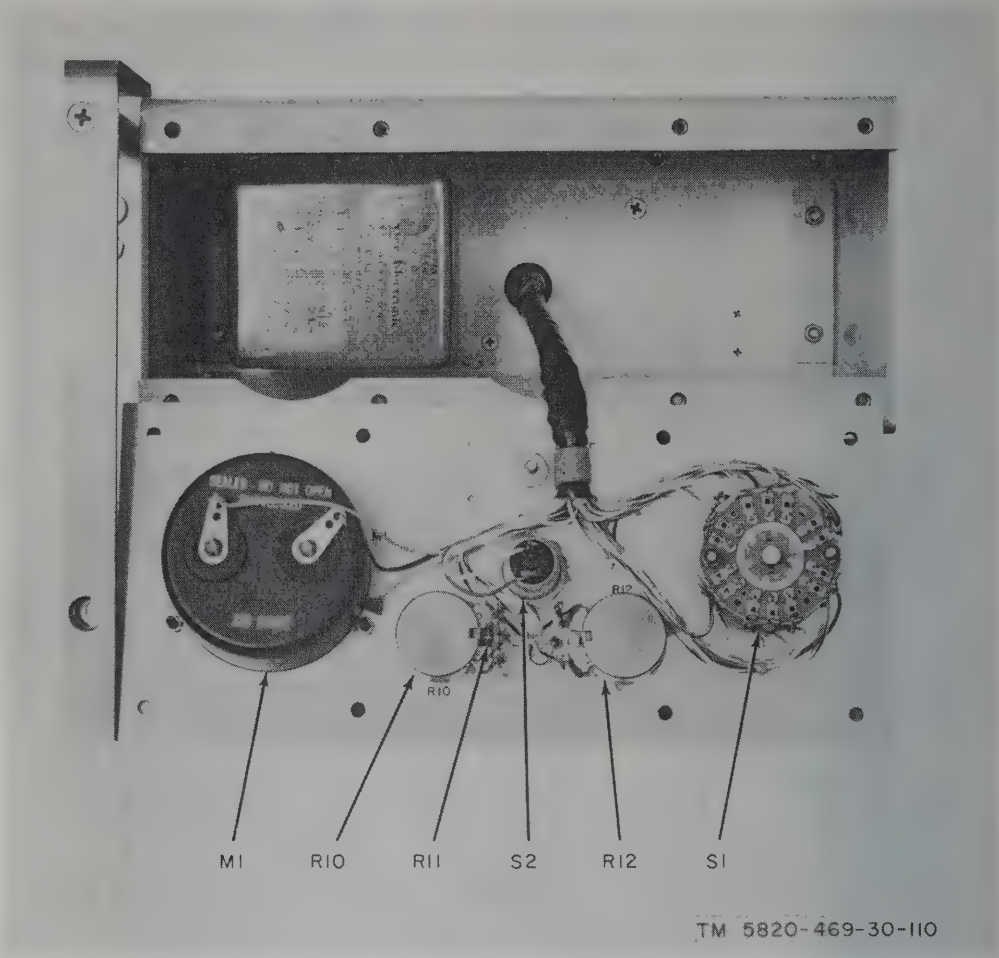


Figure 72. Receive converter, rear view of meter panel.

the 200-volt power supplies or to defects in the power supply chassis. Since the three 200-volt power supplies are identical with 200-volt power supply A1 in the transmit converter, refer to paragraph 231 for the troubleshooting procedures if the checks below indicate that a defective 200-volt power supply is contained within the IF amplifier power supply. If all three 200-volt power supplies are dead, refer to paragraph 259. Use an ME–26B/U to perform the measurements listed below.

b. IF Amplifier 70-Mc (Back-to-Back) Test (fig. 75). The following in-shelter check will determine if the IF amplifier is defective or if the trouble is external to the IF amplifier. The output of the modulator-multiplier is used as the 70-mc source for this test.

Test point	Normal indication (volts dc)	Defective po supply
J1	200	A1
J2	200	A2
J3	190	A3
J4	—6.3	Defect in p supply ma frame. Re paragraph

(1) Unscrew the four right-hand scr which secure the modulator-multip (fig. 67) to rack A1, and swing the chassis.

(2) Remove connector P1 (cable 31W from chassis connector J6 (fig. 7

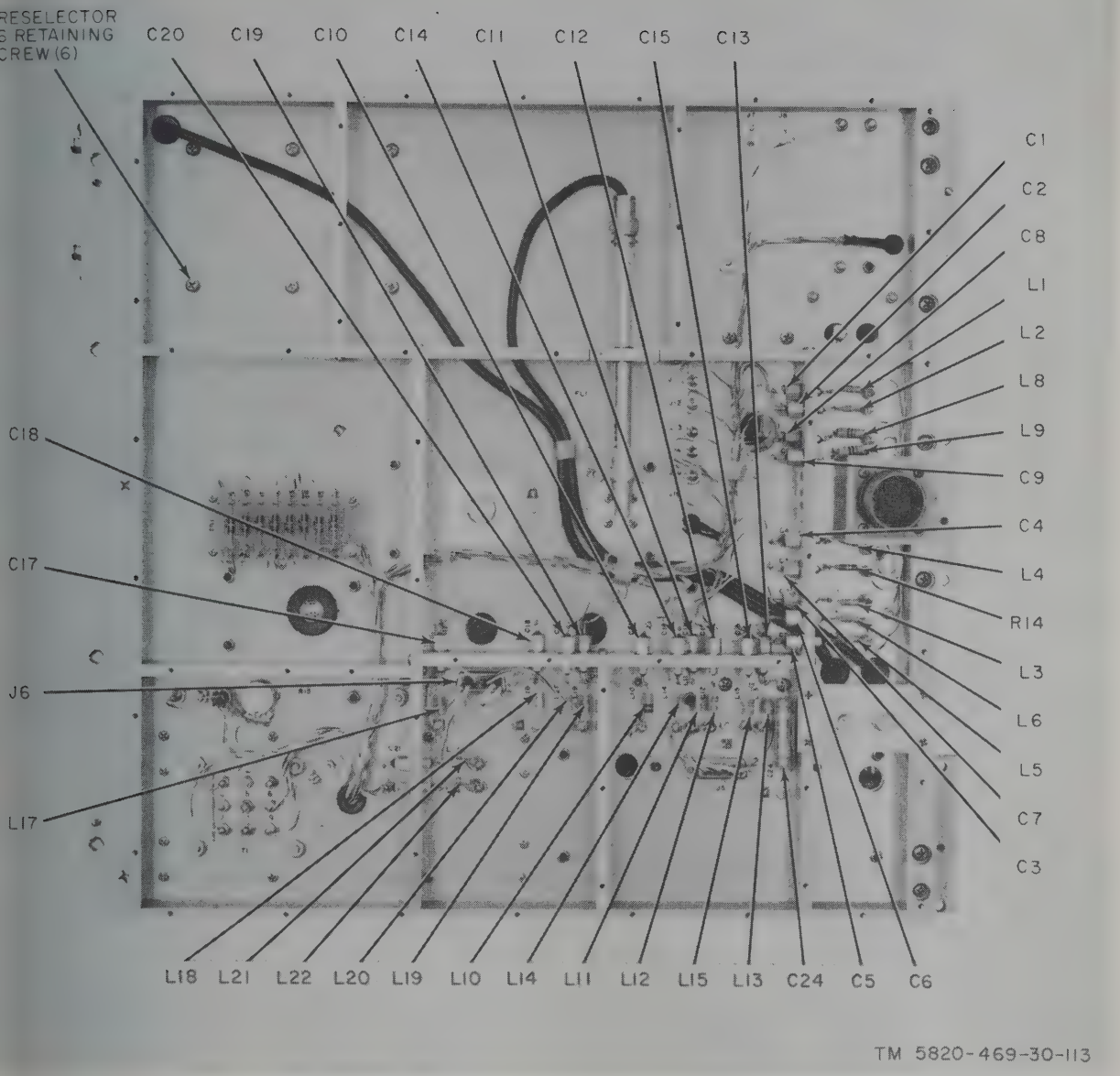


Figure 73. Receive converter, rear view, (part 1 of 2).

(3) Connect the BNC-BNC test cable (item 19, test facilities kit, fig. 150) to J6.

(4) Assemble a 20-db attenuator, using items 11, 3, 14, and 8 (in that order) of the test facility kit (fig. 150).

(5) Connect one end of the attenuator (item 11) to the free end of the test cable (item 19) used in (3) above.

(6) Locate the two short coaxial cables (fig. 23, TM 11–5820–469–10) which normally connect RECEIVER OUT NO. 1 to IF IN NO. 1 (J8 to J9), and RECEIVER OUT NO. 2 to IF IN NO. 2 (J10 to J11) on the switch panel in rack A2.

Note. This equipment contains two identical IF assemblies. The connections given in (7) below will check IF amplifier No. 1

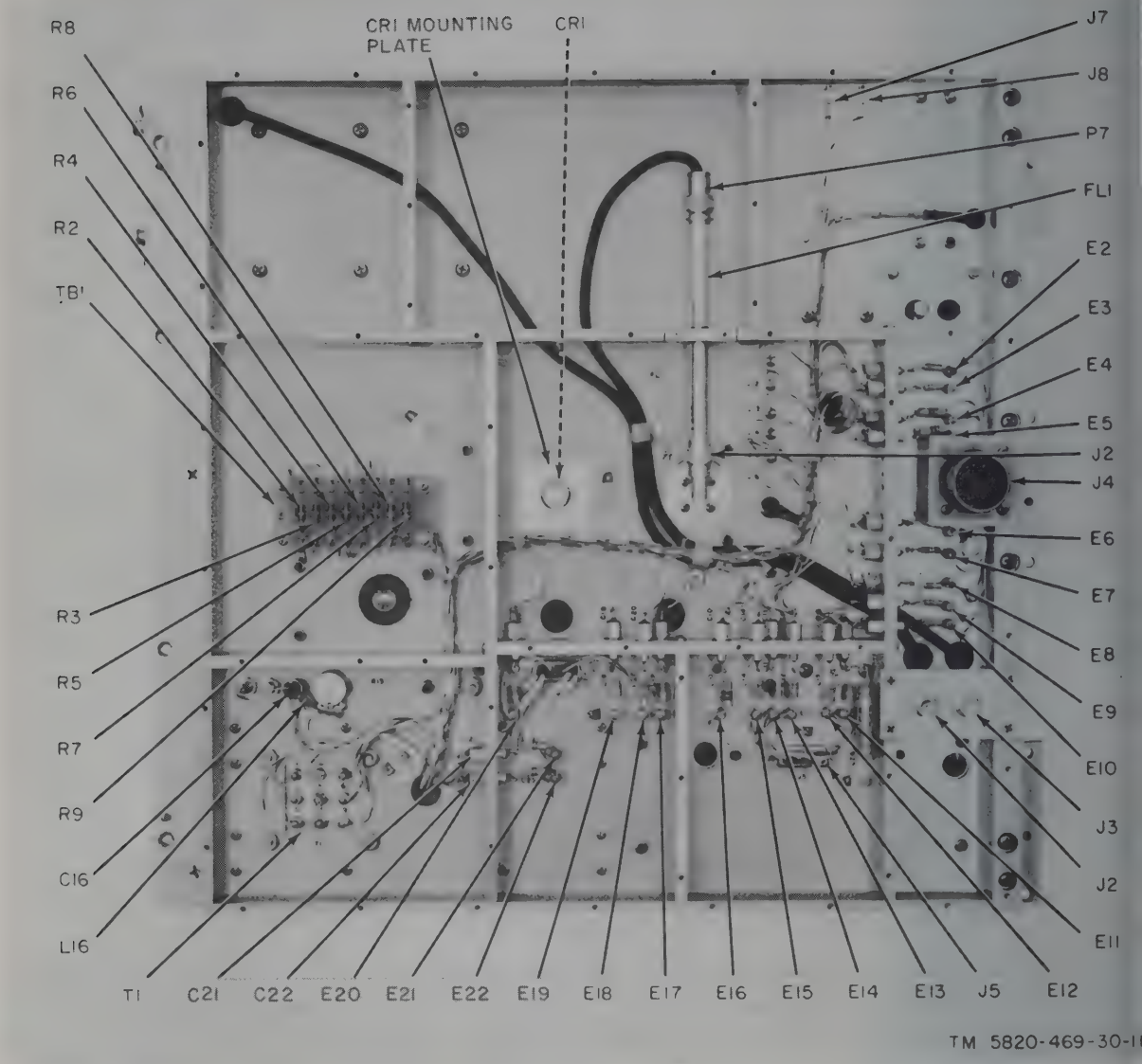


Figure 73. Receive converter, rear view (part 2 of 2).

(located in rack No. 5), and (8) below will check IF amplifier No. 2 (located in rack No. 4).

(7) Test connections for IF amplifier No. 1 are made by connecting the cable from J9 (fig. 23, TM 11–5820–469–10) to item 8 of the assembled 20-db attenuator assembly. The 70-mc output of the modulator-multiplier is now connected through a 20-db attenuator to the 70-mc input of IF amplifier 1.

(8) Test connections for IF amplifier 2 are made by connecting the c from J11 to the attenuator assem

(9) In rack A2, depress the TEST S NAL pushbutton on the control pa and place the POWER switch of IF power supply under test to

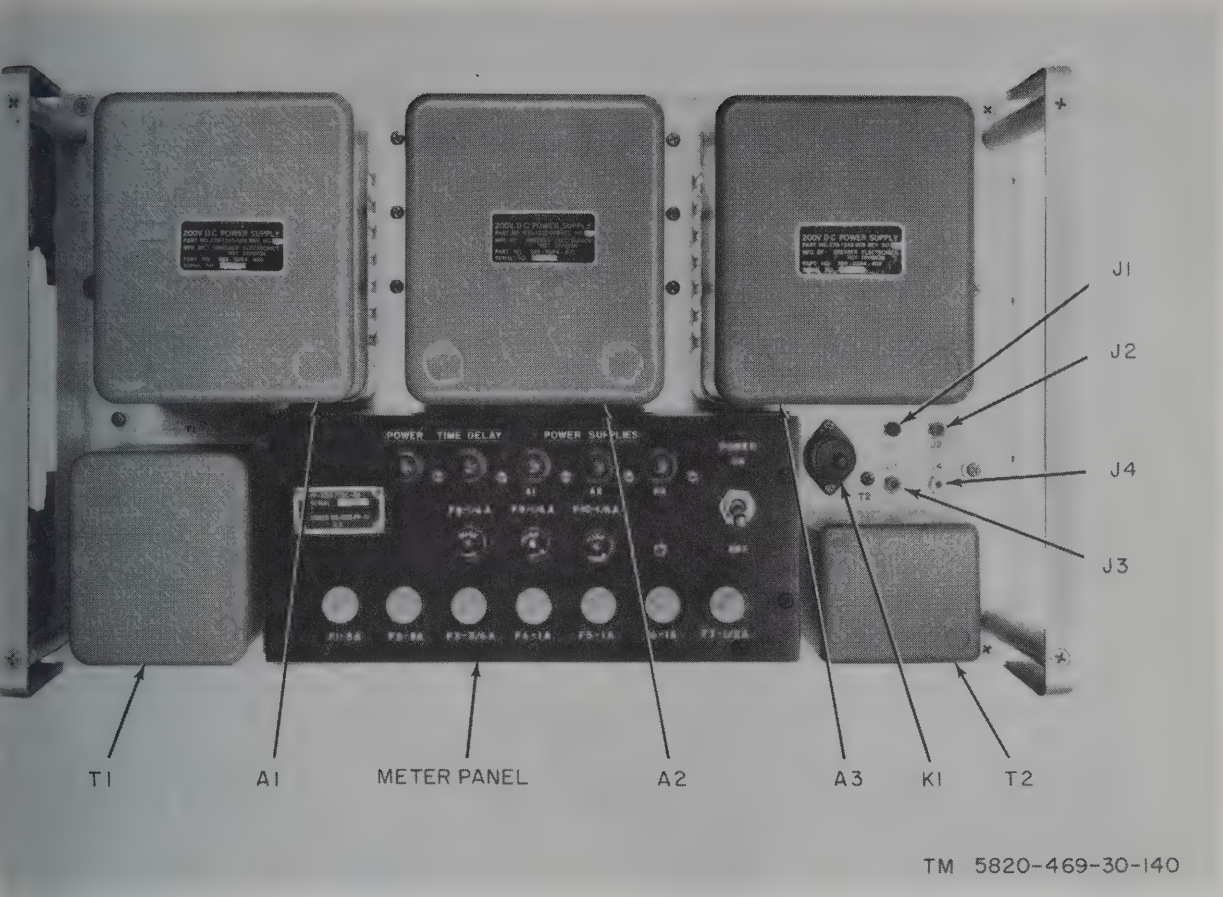


Figure 74. IF amplifier power supply, front view.

(10) Check the meter indications on the monitor panel (fig. 19, TM 11–5820–469–10) in the following order:

(*a*) Set S2 to position B, LINE VOICE IN. Adjust the TEST SIGNAL LEVEL control on the control panel for a SET POINT meter indication on the monitor.

(*b*) Set S2 to position C, EXCITER VOICE IN (order-wire voice level input to the modulator multiplier). Adjust multiplexer voice input level adjust control R29 (fig. 12, TM 11–5820–469–20) for a SET POINT meter indication on the monitor.

(*c*) Set S2 to position A, VOICE DEVIATION. Adjust modulator-multiplier OW DEV control R17 (fig. 14, TM 11–5820–469–20) for a SET POINT meter indication. (This establishes the proper 9-kc peak deviation at 70 mc.)

(*d*) Set S2 to position D, RECEIVE VOICE OUT. Adjust OUTPUT LEVEL control R31 (fig. 21, TM 11–5820–469–20) on the discriminator-combiner module of the IF amplifier under test to establish the proper audio output level.

Note. This adjustment cannot be made on IF amplifier No. 1 (rack A5) if IF amplifier No. 2 (rack A4) has been removed. (Combiner and redundancy connections are made from IF amplifier No. 1 to IF amplifier No. 2. Combined receiver output is taken *only* from IF amplifier No. 2.)

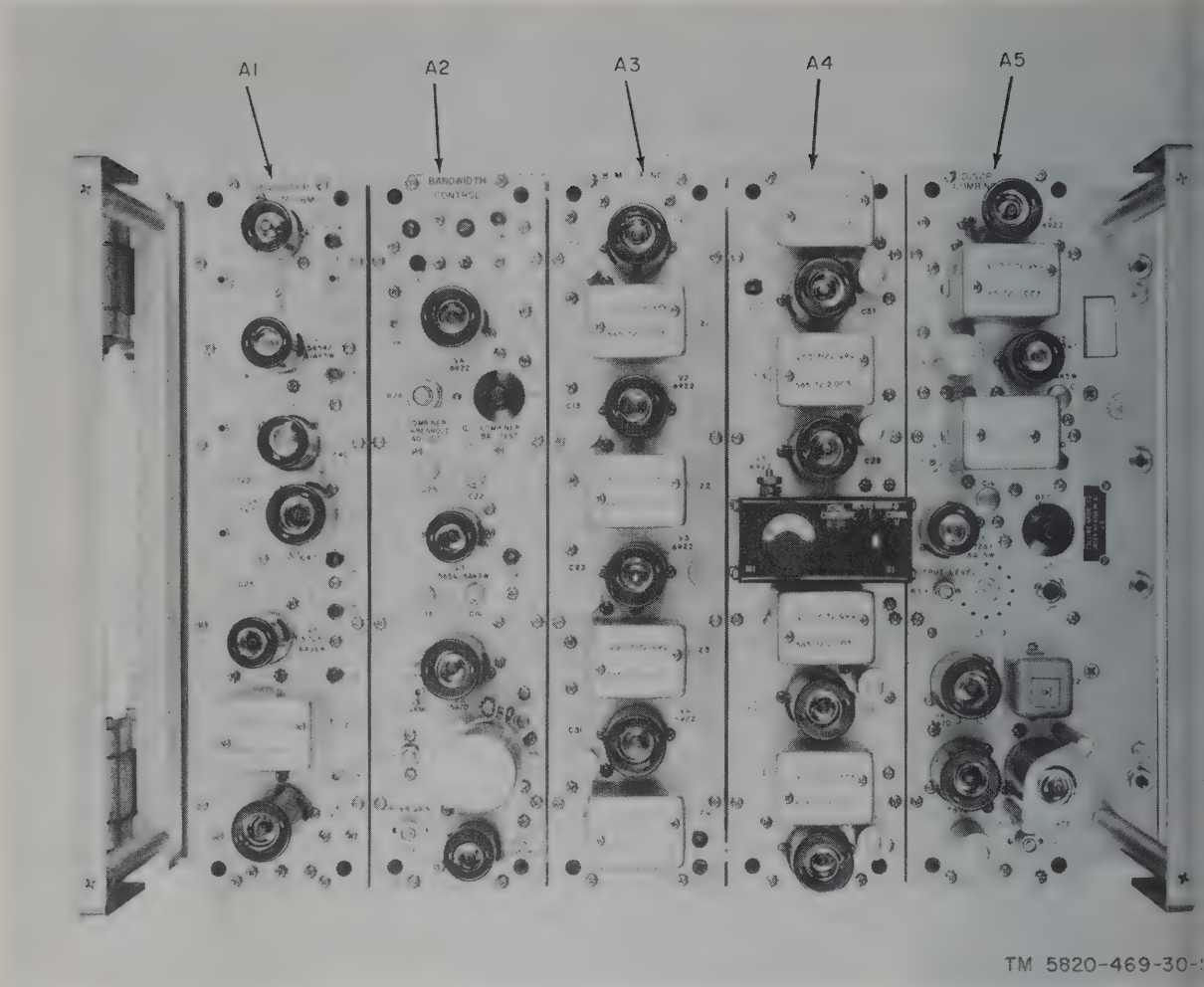


Figure 75. IF amplifier (No. 1 or No. 2), front view.

(11) If the above SET POINT meter indications are obtained, the IF amplifier is operating properly. If this last meter reading is not obtained or cannot be properly adjusted, the IF plifier chassis is faulty. Refer paragraphs 237 and 252.

Section II. RECEIVE CONVERTER TROUBLESHOOTING PROCEDURES

240. General

When the recommended checks and corrective measures in the organizational maintenance manual (TM 11–5820–469–20) do not restore normal operation and the localizing checks in paragraph 238 indicate that trouble exists in the receive converter, perform the applicable procedures in this section. The following data will assist the repairman in trou shooting the receive converter:

Data	References
Receive converter main frame components	Figs. 71, 72, an
Tuneup oscillator and mixer A4 components	Figs. 77 throug

DATA	REFERENCES
eup oscillator and mixer A4	Fig. 80.
ltage and resistance diagram	
preamplifier A9 components	Figs. 82, 83, and 84.
preamplifier A9, voltage and sistance diagram	Fig. 85.
ive converter power supply mponents	Figs. 86, 89, and 90.
ive converter power supply ltage and resistance diagram	Fig. 88.
ve converter functional de- ription	Paras. 87 through 96.
ive converter power supply nctional description	Para. 137.

. Receive Converter Troubleshooting

te. The removal procedures for the receive con- r are covered in paragraph 41 of TM 11–5820– 20.

Test Connections. Set the receive con- er chassis on a service bench. Use the re- er system test cable (item 30, test facilities fig. 150) and connect the equipment as il- rated in figure 76. Connect the power plug 115-volt, 60-cps source. Use the blower kit mbly (test facilities kit, fig. 150) and con- the flexible air hose between the blower the air-access hole on the rear of the receive verter chassis.

Test Signal Input. Provide local oscillator tation by one of the following methods:

(1) *Frequency synthesizer.* When the frequency synthesizer is used as the signal source, connect the output of the synthesizer at J604 (fig. 27, TM 11–5820–469–20) to oscillator unit input jack J1 (fig. 51). Adjust the synthesizer to some midband frequency (channels 595 to 927). Set INT-EXT switch S1 to EXT.

(2) *Local oscillator in oscillator unit A1.* Insert the crystal unit for channel No. 762 (item 16, test facilities kit, fig. 150) into the Y1 socket of the oscillator unit (fig. 51). Set INT-EXT switch S1 to INT.

(3) *External signal generator.* When Signal Generator AN/GRM–50 (or equivalent) is used, select a 32-mc output at a level of +16 dbm. Set INT-EXT switch S1 to EXT and apply the input signal from the signal generator to jack J1 on the oscillator unit.

c. Troubleshooting Procedure. The receive converter localizing procedures given in paragraph 238 will localize the defect to one of the modules or subchassis (oscillator, multiplier, RF preamplifier, varactor multiplier, etc.) that comprise the receive converter. After connecting the receive converter in a test setup (*a* above), refer direct to the paragraph in this section that covers troubleshooting procedures for the suspected module or subchassis. When no meter indications are obtained, or if the power indicators on the receive converter power supply do not light, refer to the receive converter power supply troubleshooting procedures (para. 249).

242. Oscillator Unit A1 Troubleshooting Procedures

Note. When the AN/TRC–80 is used as part of the Pershing Weapons System, EXT-INT switch S1 is normally set to EXT (signal input from synthesizer). In this application, a failure within oscillator stage V1 will *not* affect normal receive converter operation.

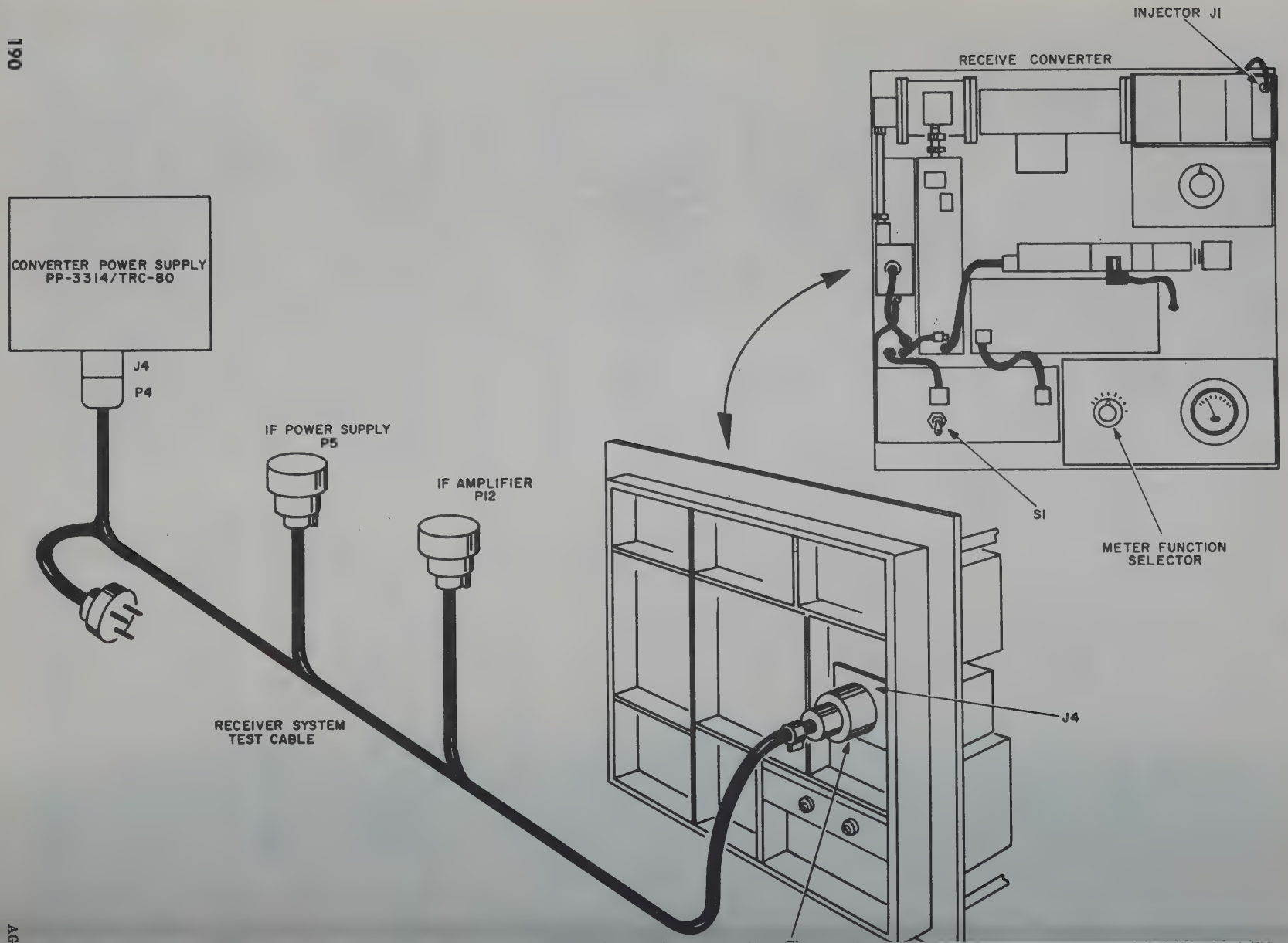
a. Failure to obtain satisfactory readings on meter M1 when the METER FUNCTION SELECTOR switch is in the A or NULL A position (para. 238, steps 1 and 2) indicates that a defective component may be located in oscillator V1A or cathode follower V1B. An incorrect meter reading with the METER FUNCTION SELECTOR switch in the B position indicates that the defect may be located between buffer amplifiers V2 and V4. Before removing the oscillator unit from the receive converter for troubleshooting, perform the following check:

(1) Connect the receive converter as directed in paragraph 241.

(2) Set XTAL CURRENT ADJUST control R10 fully clockwise.

(3) Disconnect plug P3 from jack J1 (fig. 55) on the multiplier unit.

(4) Connect the 20 db attenuator (item 3, test facilities kit, fig. 150) to P3.


INJECTOR J1
RECEIVE CONVERTER
CONVERTER POWER SUPPLY
PP-3314/TRC-80
J4
P4
IF POWER SUPPLY
P5
IF AMPLIFIER
P12
S1
METER FUNCTION
SELECTOR
RECEIVER SYSTEM
TEST CABLE
J4

(5) Connect Adapter, N female to TNC female (item 10, test facilities kit, fig. 150) to the attenuator (4) above).

(6) Connect Radio Frequency Power Test Set AN/USM–96A to the adapter ((5) above).

(7) Adjust R10 for an indication of approximately 1.0 milliwatt.

(8) If an indication of 1.0 milliwatt is obtained, the oscillator unit is performing satisfactorily. Check the connections to meter M1 on the receive converter. If an indication of 1.0 milliwatt is not obtained, proceed to *b* below.

. Oscillator unit A1 in the receive converter lentical with oscillator unit A2 used with the ısmit converter. To prepare the oscillator troubleshooting or repairs, remove the os- ıtor unit from the receive converter chassis ra. 278*j*) and connect the test cable ex- der (item 28, test facilities kit, fig. 150) veen P1 (fig. 52) on the oscillator unit and on the receive converter. Refer to figures 52, and 53 for the component locations, and igure 155 for the complete schematic dia- m. Perform the voltage and resistance surements (fig. 54) to locate the defective ponent.

. Multiplier Unit A2 Troubleshooting Procedures

Iultiplier unit A2 in the receive converter lentical with multiplier unit A3 used in the ısmit converter. Troubleshooting proced- s for both multiplier units are similar, ex- that the test cable extender (para. 227*b*) onnected between P1 on the multiplier unit J6 on the receive converter (fig. 73). pt the procedures in paragraph 227 for bleshooting multiplier unit A2. An AN/ M–96A reading of 4.75 milliwatts (instead he 5.25 milliwatt listed in para. 227*a*(6)) cates that the multiplier unit A2 is func- ing normally.

. Receive Converter Varactor Multiplier Troubleshooting Procedures

Failure to obtain satisfactory meter indications (para. 238*b*, steps 8 and 9) when METER FUNCTION SELECTOR switch S4 is set to position G or H-XTAL CUR indicates that a defect probably exists in varactor multiplier assembly unit A3 or in an associated circuit component. To isolate the trouble, perform the following checks:

Note. Connect the receive converter as specified in paragraph 241*a*.

(1) Verify that both the oscillator and multiplier units are operating normally (paras. 242 and 243) before testing the varactor multiplier.

(2) Disconnect plug P8 from J3 on the 70-mc tuneup oscillator and mixer assembly (fig. 77).

(3) Connect the 10db attenuator (item 1, test facilities kit, fig. 150) to the input connector of Radio Frequency Power Meter AN/USM–96A. Connect Adapter, N female to TNC male (item 10, test facilities kit, fig. 150) between the attenuator and P8.

(4) Turn on the power. The AN/USM–96A should indicate approximately 2.5 milliwatts.

b. If the test above indicates normal operation, check the 70-mc tuneup oscillator and mixer assembly (para. 245). If a reading of 2.5 milliwatts is not obtained (*a*(4) above), check for a defective component within the varactor multiplier assembly. Refer to figures 71 and 73 for the locations of components associated with the varactor multiplier. Figures 59, 60, and 61 illustrate the components mounted on (or within) the varactor multiplier subchassis. Figure 161 is the receiver converter main chassis complete schematic diagram.

245. Seventy-Mc Tuneup Oscillator and Mixer A4 Troubleshooting

Failure to obtain a satisfactory meter indication (para. 238*b*, step 12) when the METER FUNCTION SELECTOR switch is set to the 70 MC position indicates that a defect may exist in 70-mc tuneup oscillator and mixer unit A4. To isolate the trouble, perform the following procedure.

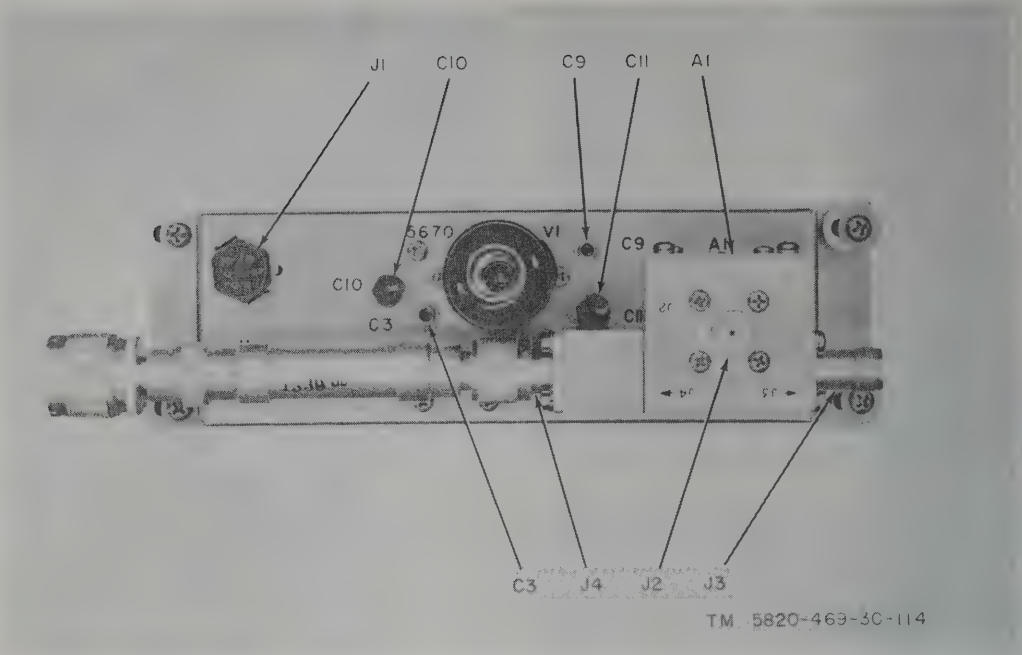


Figure 77. 70-mc oscillator and mixer A4, top view.

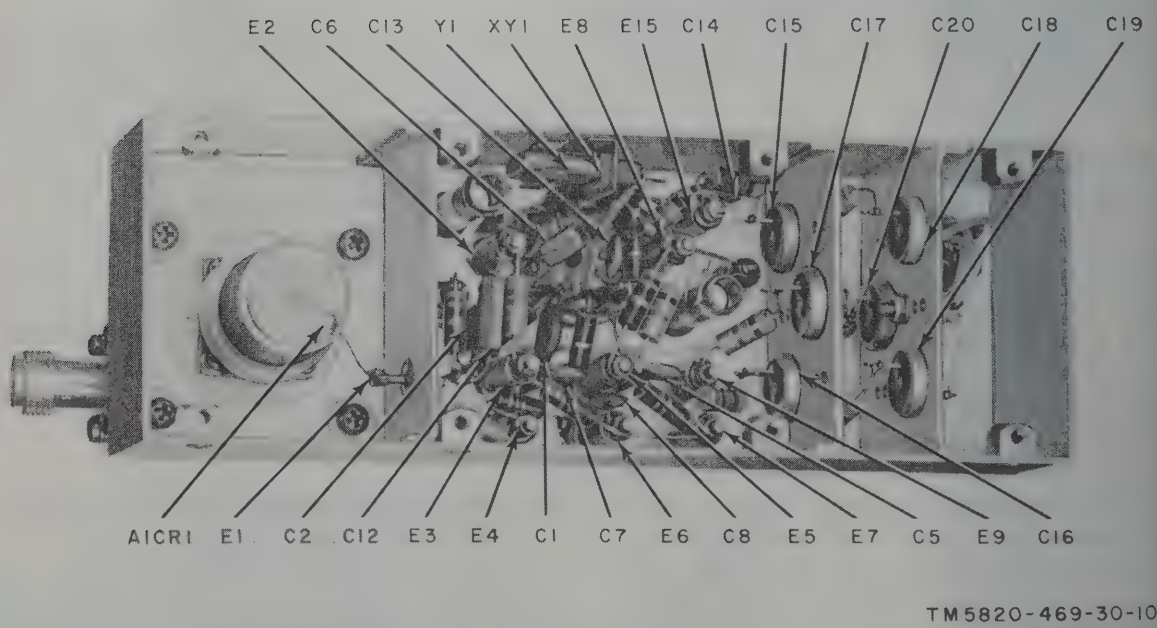


Figure 78. 70-mc tuneup oscillator and mixer A4, bottom view, location of components.

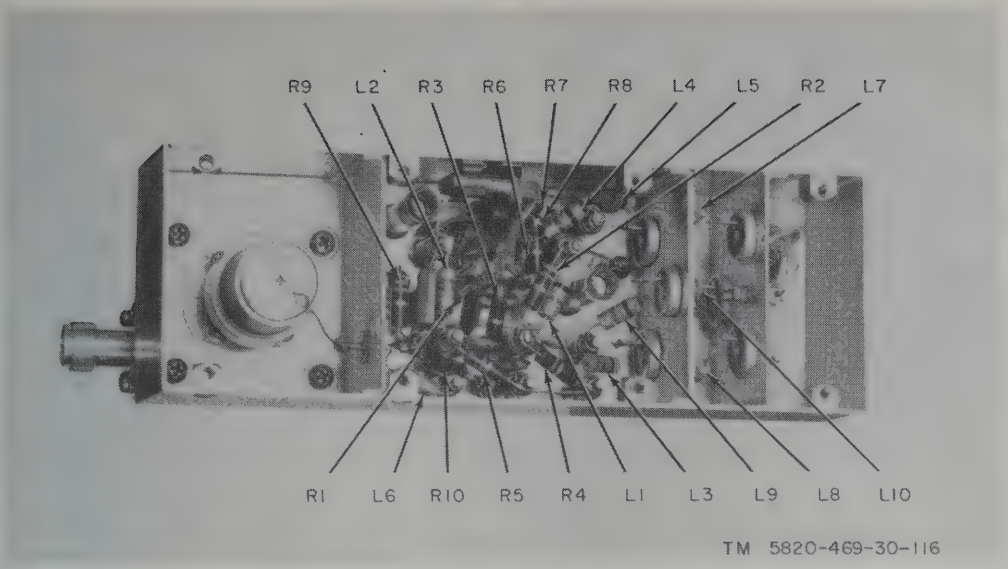
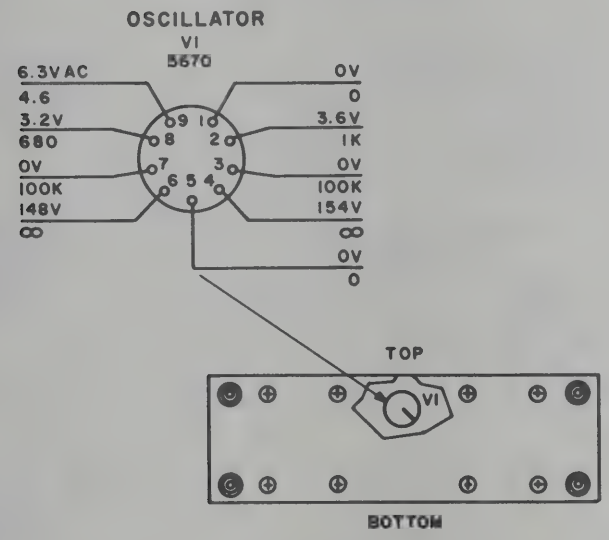


Figure 79. 70-mc tune oscillator and mixer A4, bottom view, location of resistors and coils.



NOTES:

1. VOLTAGE MEASURED TO GROUND WITH A VTVM WITH ALL UNITS INSTALLED AND TUNE-UP SIGNAL SWITCH DEPRESSED
2. RESISTANCE MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER
3. VOLTAGE READINGS ARE ABOVE THE LINE, RESISTANCE READINGS ARE BELOW THE LINE
4. REMOVE POWER PLUG P10 FROM JACK J1 BEFORE MAKING RESISTANCE MEASUREMENTS

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Figure 80. 70-mc tuneup oscillator and mixer A4, voltage and resistance diagram.

a. Verify that the oscillator, multiplier, and ractor multiplier (paras. 242–244) are func-ning normally.

b. Remove all connecting cables from 70-mc neup oscillator and mixer unit A4.

c. Loosen the captive mounting screws on unit A4 and remove unit A4 from the receive converter main frame.

d. Connect the test cable extender (item 27, test facilities kit, fig. 150) between P10 (fig. 71) and J1 (fig. 77) on unit A4.

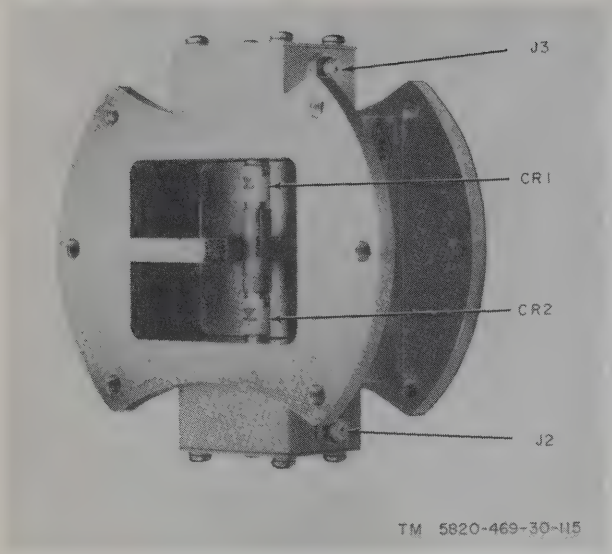


Figure 81. Balanced mixer A8, location of components.

e. Perform the voltage and resistance measurements to locate the defective component. Refer to figures 77, 78, 79, and 81 for the component locations, and to figure 6 for the complete schematic diagram. Figure 80 lists the voltage and resistance measurements.

246. Balanced Mixer A8 Troubleshooting Procedures

a. Failure to obtain a satisfactory meter indication (para. 238*b*, step 10) when the METER FUNCTION SELECTOR switch is set to the J-TUN. DET position indicates that a defect may exist in balanced mixer A8. To check the balanced mixer, perform the following procedures:

(1) Set TUN. DET METER ADJUST control R12 fully clockwise.

(2) Depress the TUNE-UP SIGNAL button.

(3) Set the METER FUNCTION SELECTOR switch to the J-TUN. DET position and check for a full-scale meter deflection.

b. If the indication in *a*(3) above is unsatisfactory, check crystals CR1 and CR2 in the balanced mixer (fig. 81). If the indication is satisfactory when the TUNE-UP SIGNAL button is depressed but no meter indication is observed when an incoming signal is being mea ured, check the tuning of tuneup sign injector A10, preselector A6, and phase shift A7. (Refer to paragraphs 62 and 63 of T 11–5820–469–10 for the receive converter tu ing procedures.)

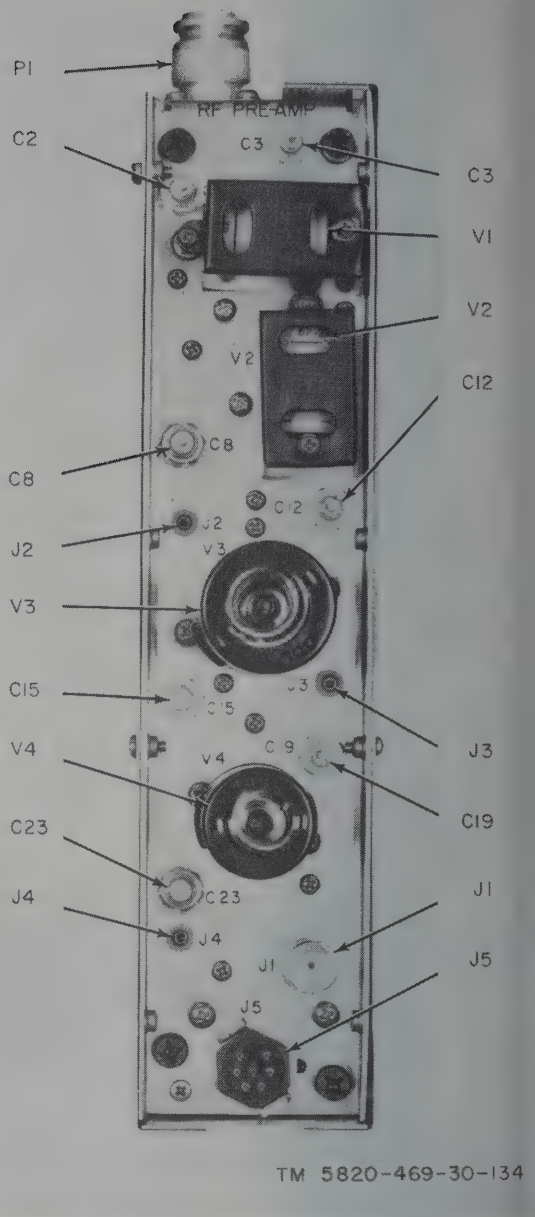


Figure 82. RF preamplifier A9 (part of receive converter), top view.

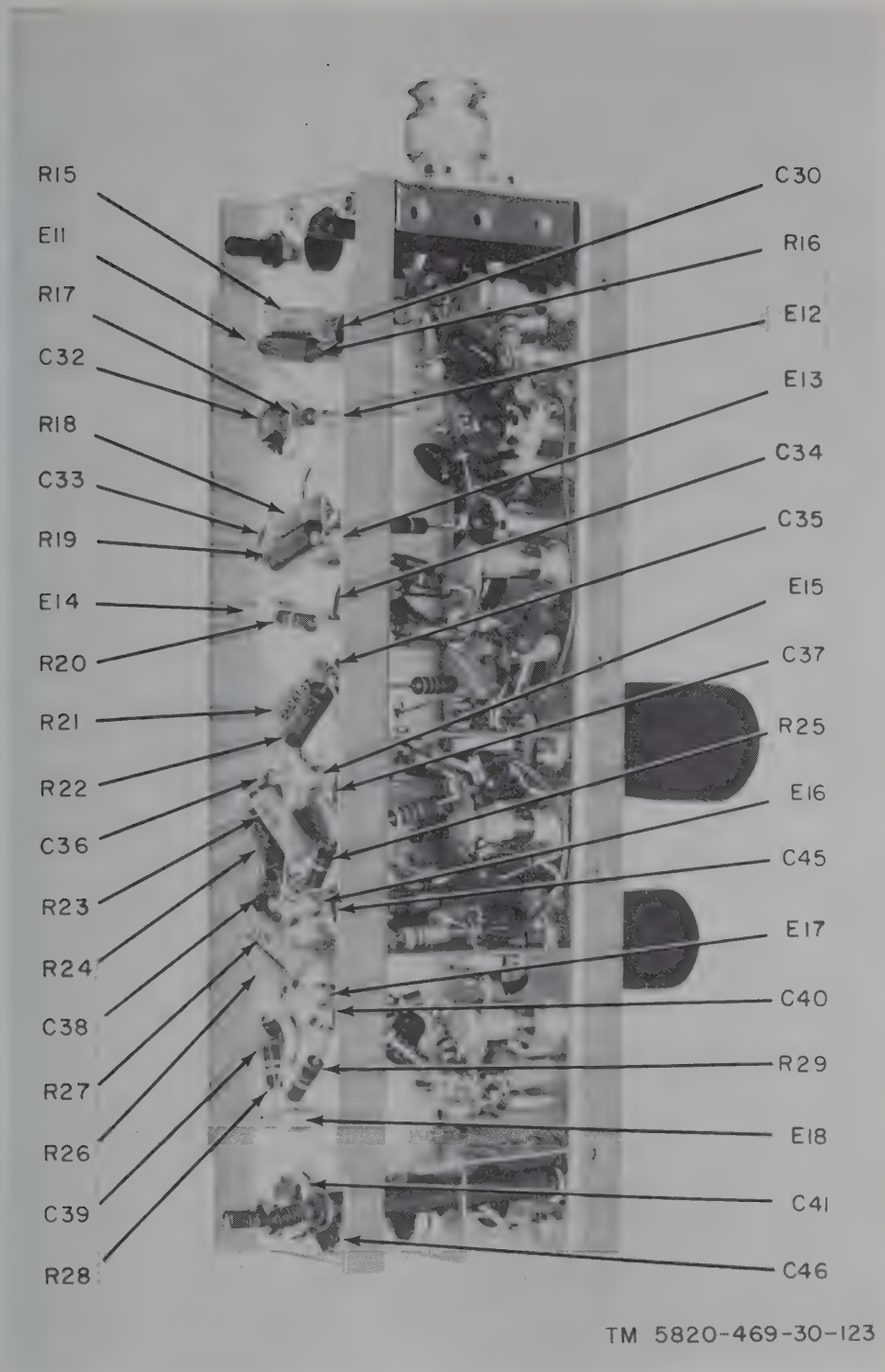


Figure 83. RF preamplifier A9 (part of receive converter), left oblique view, location of components (part 1 of 2).

c. If the crystals in the balanced mixer are od and tuneup signal injector A10, preselec- r A6, and phase shifter A7 are tuned correctly, refer to paragraph 248 for the trouble-shooting procedures on RF preamplifier A9.

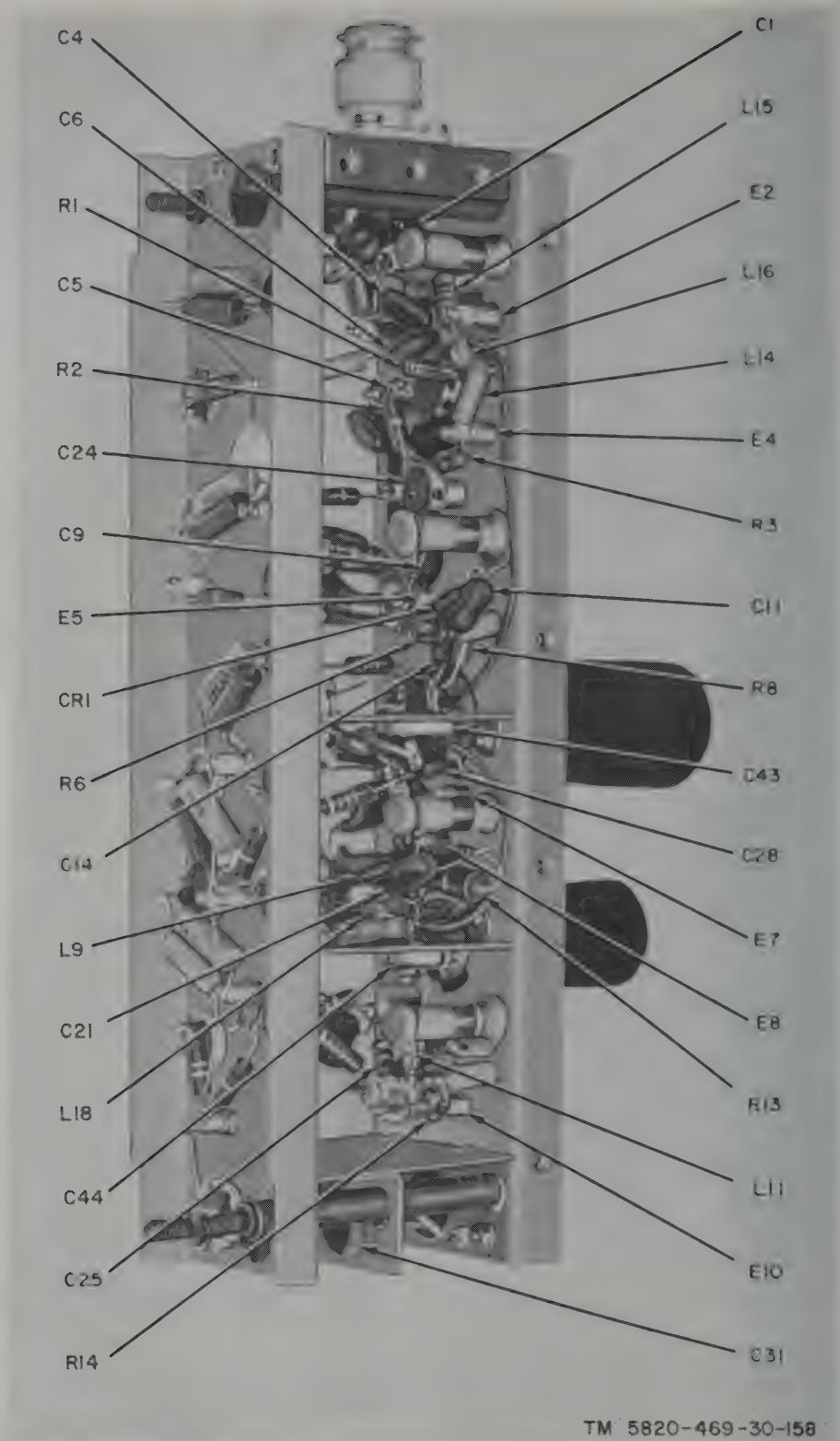


Figure 83. RF preamplifier A9 (part of receive converter), left oblique view, location of components (part 2 of 2).

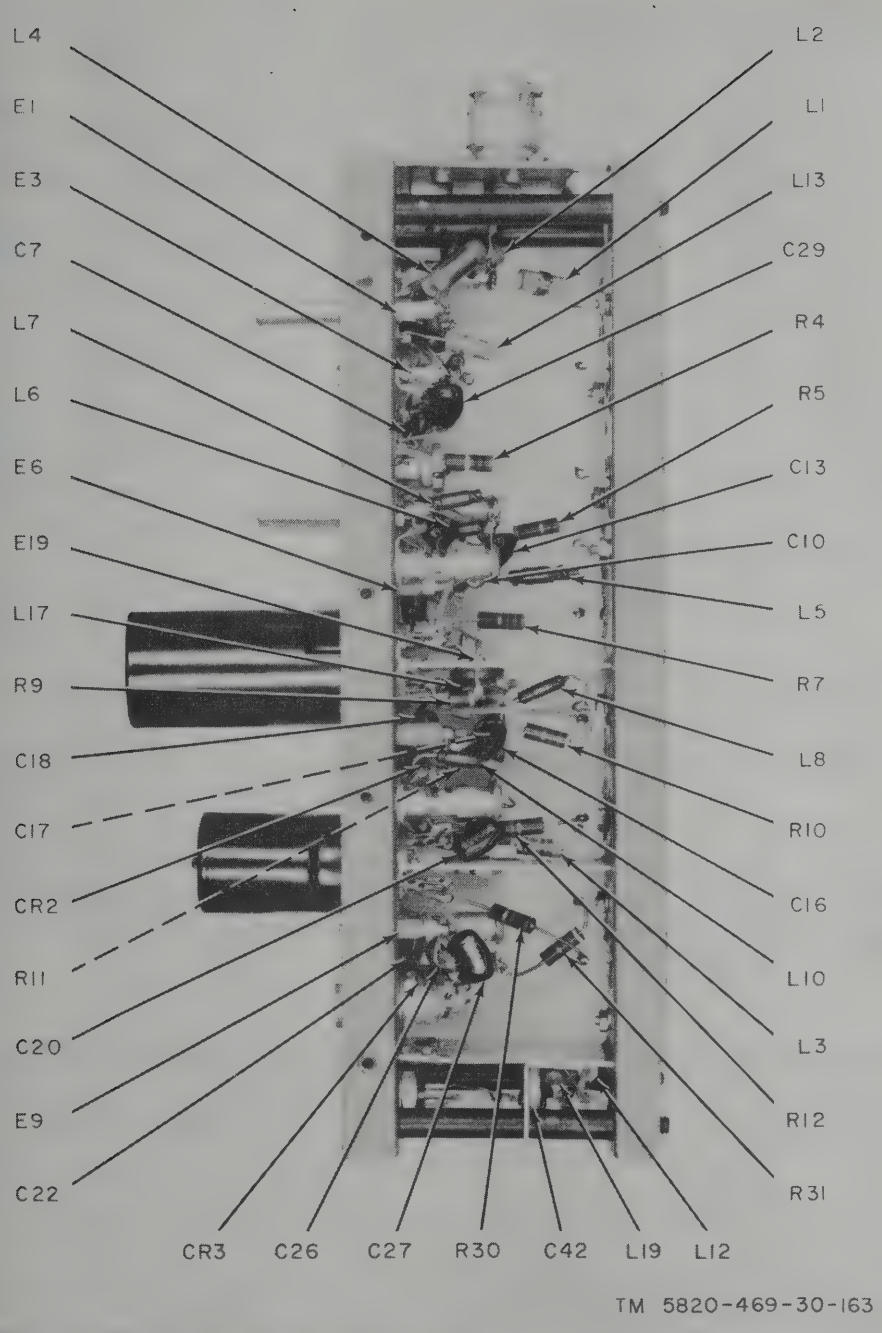


Figure 84. RF preamplifier A9 (part of receive converter), right side view, location of components.

d. If the signals to be received are near ıreshold level (very weak signals), or if in- :curate tuning of the preselector is suspected, :fer to paragraph 299 for the adjustment pro- :dures.

247. Preselector A6 and Phase Shifter A7 Troubleshooting Procedures

a. Failure to obtain a satisfactory meter indication (para. 238*b*, step 10) when the METER

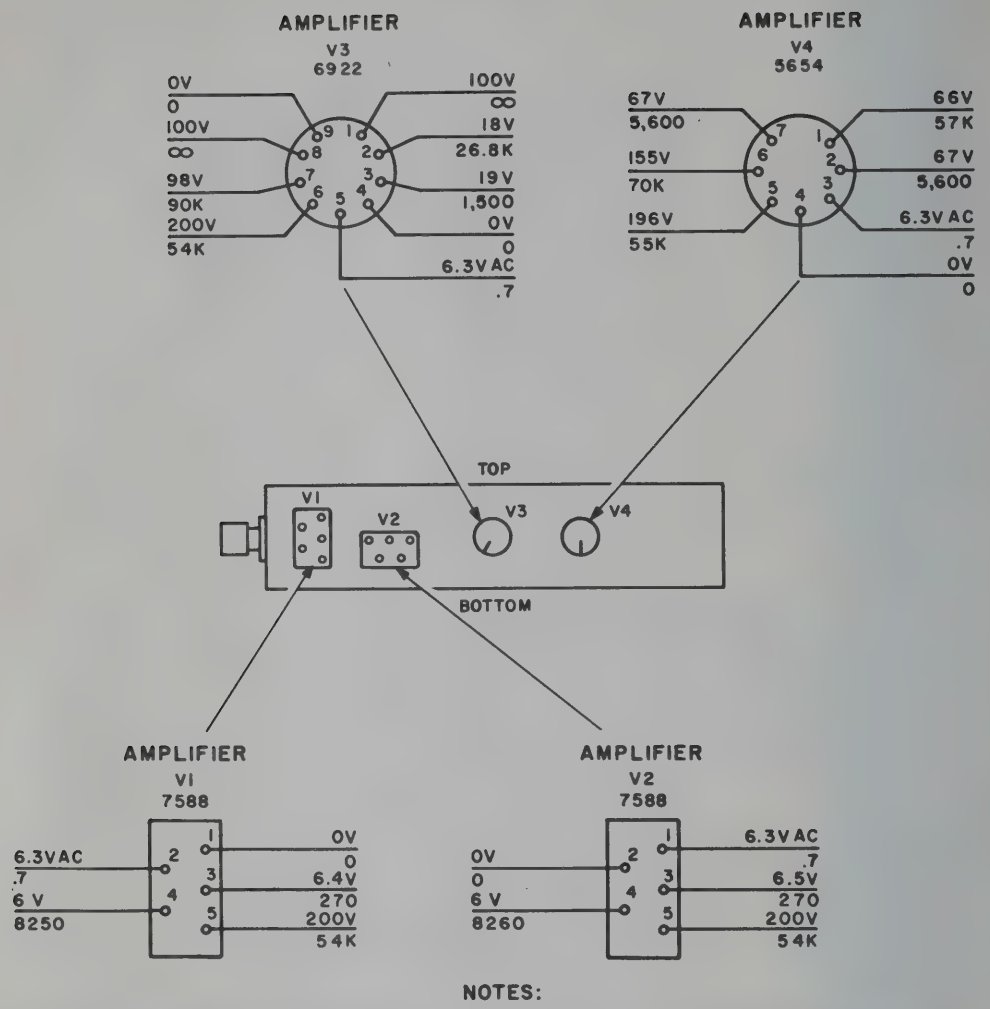


Figure 85. RF preamplifier A9 (part of receive converter), voltage and resistance diagram.

FUNCTION SELECTOR switch on the receive converter is set to the J-TUN. DET position and the recommended troubleshooting procedures in paragraph 248 do not restore normal operation may indicate that one or both of these units have been tuned to a wrong frequency. When the frequency synthesizer is used as the local oscillator signal source, check the dial settings of the preselector and phase shifter against the desired frequency of ope tion. (Refer to figure 47, TM 11-5820-469- synthesizer tuning chart, for the channel nu ber frequencies.)

b. When a signal generator or the cry oscillator in the oscillator unit of the rece converter is used (switch S1 set to INT) as local oscillator signal source, use the follow

ethod to determine the frequency of the pre-ector and phase shifter dial settings:

(1) Frequency of operation = 144 times oscillator frequency +70 mc.

(2) *For example,* assume that the oscillator input is 32.1625 mc. The frequency of operation is determined as follows:

(*a*) 32.1625 mc x 144 = 4631.4 mc.

(*b*) 4631.4 mc + 70 mc = 4701.4 mc.

(*c*) 4701.4 is the correct dial setting for an input signal of 32.1625 mc.

c. The preselector and phase shifter cannot repaired by direct support personnel. Refer paragraph 282*n* through *q* for the removal d replacement instructions.

8. RF Preamplifier A9 Troubleshooting Procedures

a. Failure to obtain a satisfactory meter in-cation (para. 238*b*, step 10) when the ETER FUNCTION SELECTOR switch is to J-TUN. DET position and the recom-ended troubleshooting procedures in para-aphs 248 and 249 do not restore normal oper-on necessitates performing the following ocedures to localize trouble in the RF pre-plifier.

b. The level of the 70-mc signal voltage that is amplified by RF preamplifier A9 is too low for significant RF measurements. To check whether a 70-mc signal is being applied to the 70- to 8-mc converter in the IF amplifier, use an ME–30B/U to measure a 0.07- to 0.1-volt dc voltage at test point J4 (fig. 93). If the voltage is missing and stage VI in the 70- to 8-mc converter is operating normally (para. 255*b*), proceed as follows:

(1) Remove the cable connectors from J1, P1, and J5 (fig. 82).

(2) Loosen the four corner-located captive screws on the RF preamplifier.

(3) Set the RF preamplifier on the bench and connect the test cable extender (item 27, test facilities kit, fig. 150) between J5 (fig. 82) on the RF preamplifier and P5 on the receive converter main frame.

(4) Refer to figure 85 and perform the voltage and resistance measurements to locate the defect. The parts locations are illustrated in figures 82, 83, and 84.

(5) If these procedures do not restore normal operation, the RF preamplifier must be serviced at a higher echelon where an RF millivoltmeter is available for signal tracing.

Section III. RECEIVE CONVERTER POWER SUPPLY TROUBLESHOOTING PROCEDURES

9. Trouble Isolation Procedure

When the defect is localized to the receive nverter power supply because of lack of B+ the receive converter, or if the meter indi-tions obtained in paragraph 238*b*, step 8, 11, 13 were abnormal, perform the following ecks before removing the power supply for ubleshooting.

a. 200-Volt Power Supply. The 200-volt wer supply used in the receive converter is ntical with the power supply used in the nsmit converter. To determine whether the wer supply is defective, use an ME–26/U and eck for 200 volts dc at jack J1 (fig. 86). If this measurement is not satisfactory (reading exceeds ±5 percent of 200 volts), refer to paragraph 231 and adapt the troubleshooting procedures for this power supply.

b. Automatic Gain Control Circuits. The operation of the agc amplifier circuits located in the power supply chassis can be observed by placing METER FUNCTION SELECTOR switch S1 on the receive converter in the H XTAL CUR position.

(1) Adjust XTAL CURRENT ADJUST control R10 (on the receive converter) fully clockwise and then fully counterclockwise. Observe that the meter in-

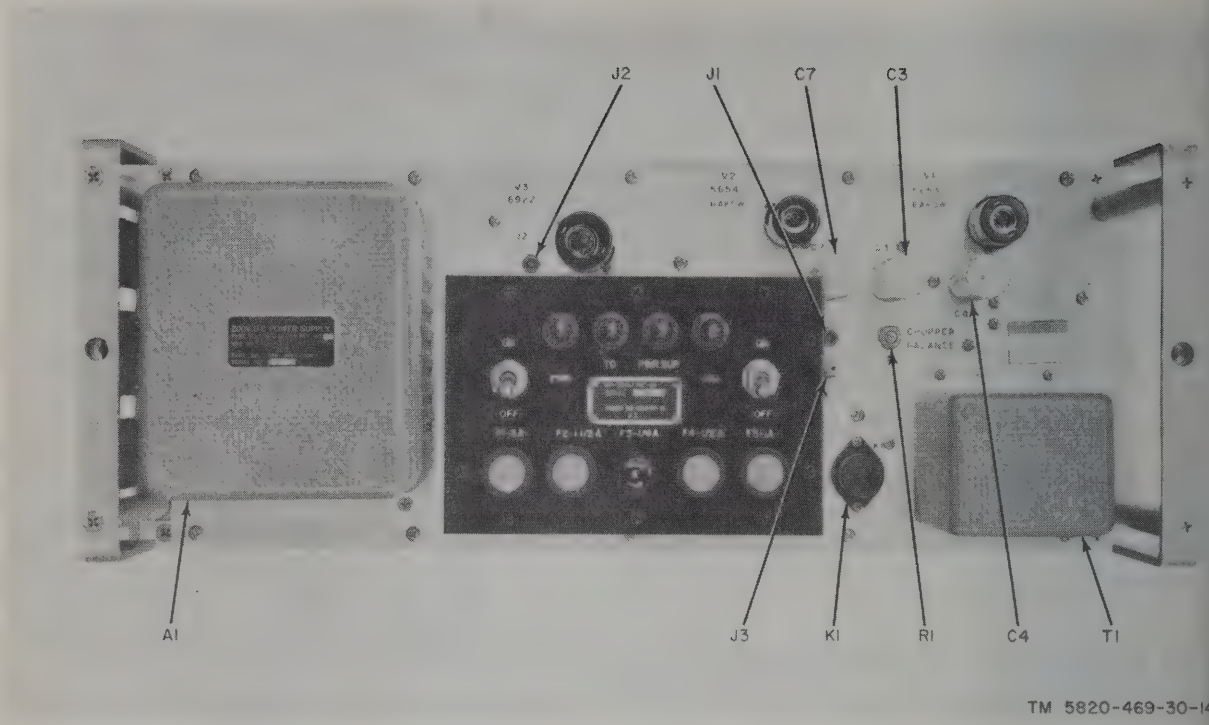


Figure 86. Receive converter power supply, location of components, front view.

dication will slowly stabilize, first above midscale and then below midscale.

(2) If this meter reaction does not result (R10 is normally adjusted for a crystal current indication of 50), the receive converter power supply is probably defective. Refer to paragraph 231.

Note. The following may also cause unsatisfactory H XTAL CUR meter indications: Defective mixer crystals in the receive converter (para. 246), a loss of local oscillator output voltage (check output from the varactor multiplier (para. 244)), or faulty cables and interconnections. If these checks do not restore normal operation, proceed as follows:

(3) Remove plug P1 (fig. 71) from J1 on the oscillator unit of the receive converter chassis (or remove crystal Y1 if internal excitation is in use). Place METER FUNCTION SELECTOR switch S1 in the AGC position. The meter should record 10 or less, indicating little or no output from the a chopper amplifier.

(4) If the above indication is not obtaine the chopper amplifier portion of t receive converter power supply m be defective. Refer to paragraphs 2 and 251.

250. Receive Converter Power Supply Test Setup

Refer to figure 87 and connect the convert power supply test set (test facilities kit, f 150) to the receive converter power supply.

251. Agc Circuit Test

The tests listed in *a* below will verify prop operation of the agc amplifier circuit (V1, V and V3, fig. 20 TM 11–5820–469–20). T INPUT VOLTAGE control on the convert power supply test set (fig. 150) will provide 0- to 100-millivolt input to the agc amplifi circuit. Use the ME–26/U for measuremen at J3, and the ME–30B/U at J2 (fig. 86). Ze

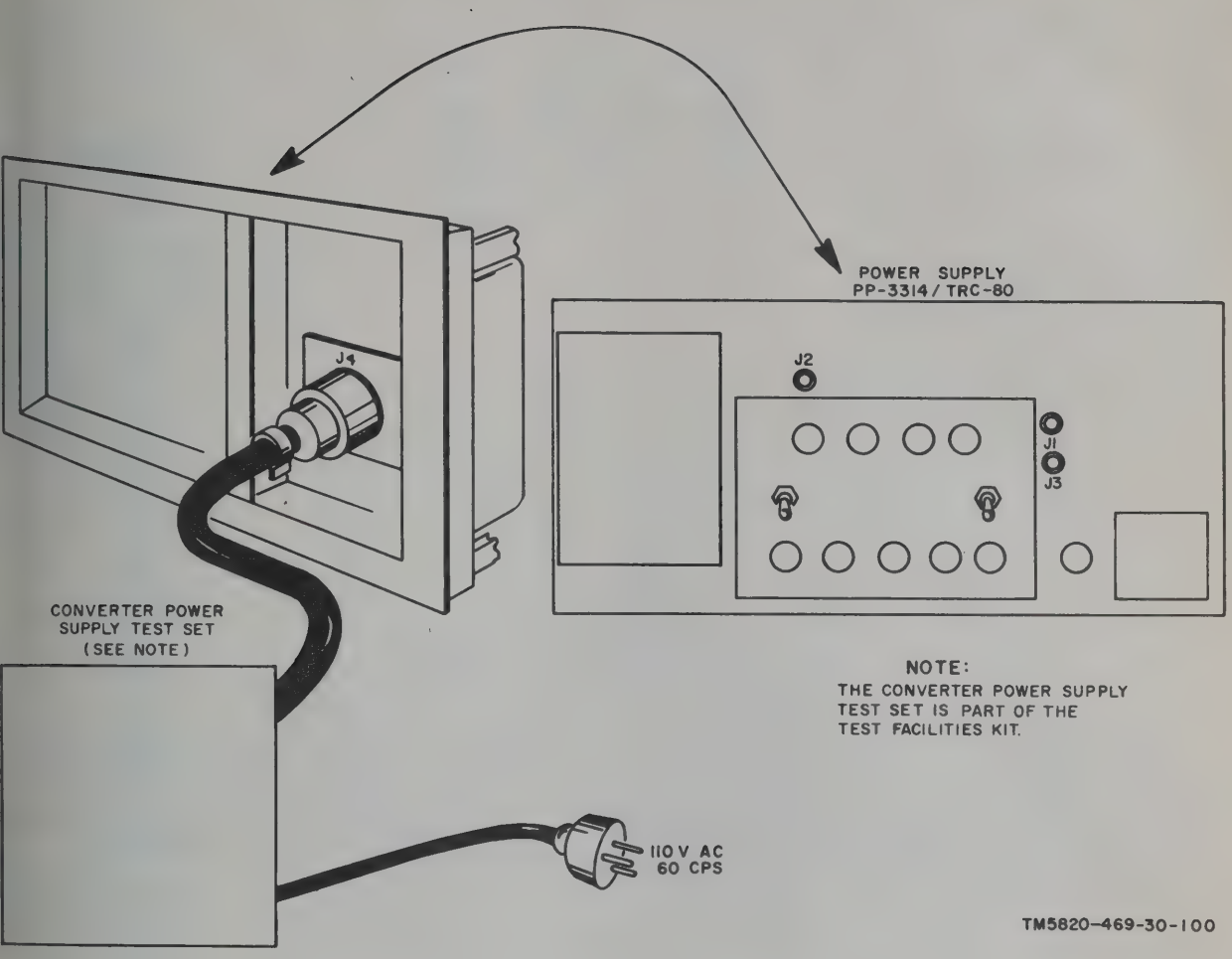


Figure 87. Receive converter power supply, test setup.

input is obtained with the INPUT VOLT-GE control in the extreme counterclockwise osition; 100 millivolts is obtained in the ex-eme clockwise position. The equipment ould be connected as specified in paragraph 0.

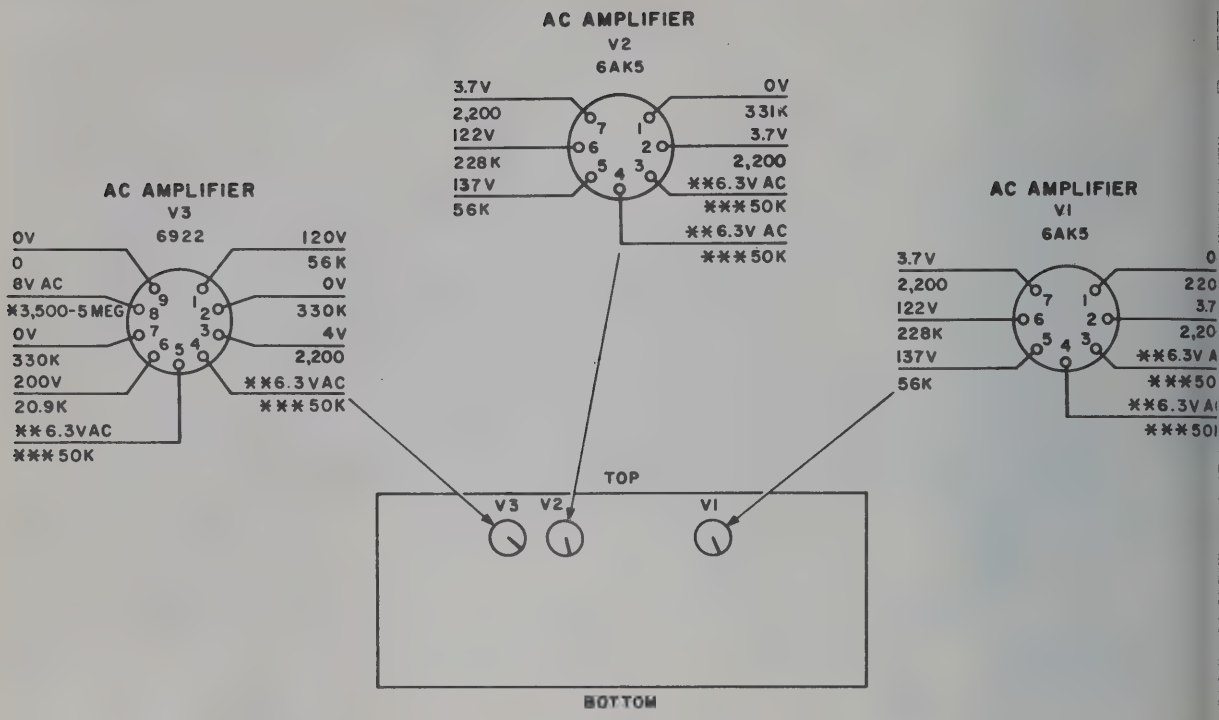
a. Typical Measurements.

Input voltage (millivolts)	J2 (volts ac)	J3 (volts dc)
0	1.35 (noise)[a]	−12.0[a] (noise)[b]
10	5.3	−36[a]
20	9.9	−56[a]
30	14.5	−3.1
40	18.5	−17.5
50	23	−35
60	27	−38
70	31	−40
80	35.5	−40.5
90	41	−42
100	47	−42.5

[a] Millivolts.

[b] Residual noise may be adjusted by CHOPPER BALANCE Control R1.

b. Troubleshooting Data. If the readings in *a* above are normal, the agc circuits are functioning correctly. When satisfactory readings



NOTES:

1. VOLTAGES MEASURED TO GROUND WITH A VTVM (ME-26/U)
2. VOLTAGE READINGS WERE MADE WITH 115V AC APPLIED TO TB1
3. RESISTANCE MEASUREMENTS WERE MADE WITH ALL PLUGS DISCONNECTED AND WITH A 20,000 OHM-PER-VOLT METER
4. VOLTAGE READINGS ARE ABOVE THE LINES, RESISTANCE READINGS ARE BELOW THE LINES

* READING DEPENDS ON METER POLARITY AND METER RANGE

** AC VOLTAGES ARE MEASURED PIN TO PIN WITH A MULTIMETER

*** RESISTANCE TO GROUND VARIES WITH CAPACITOR CHARGE, SHOULD NOT BE LESS THAN 50K

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Figure 88. Receive converter power supply, age amplifier section, voltage and resistance diagram.

cannot be obtained, perform voltage and resistance measurements (fig. 88) to locate the defective component. Figures 89 and 90 illustrate the component locations in the receive converte power supply. Figure 171 illustrates the com plete schematic diagram.

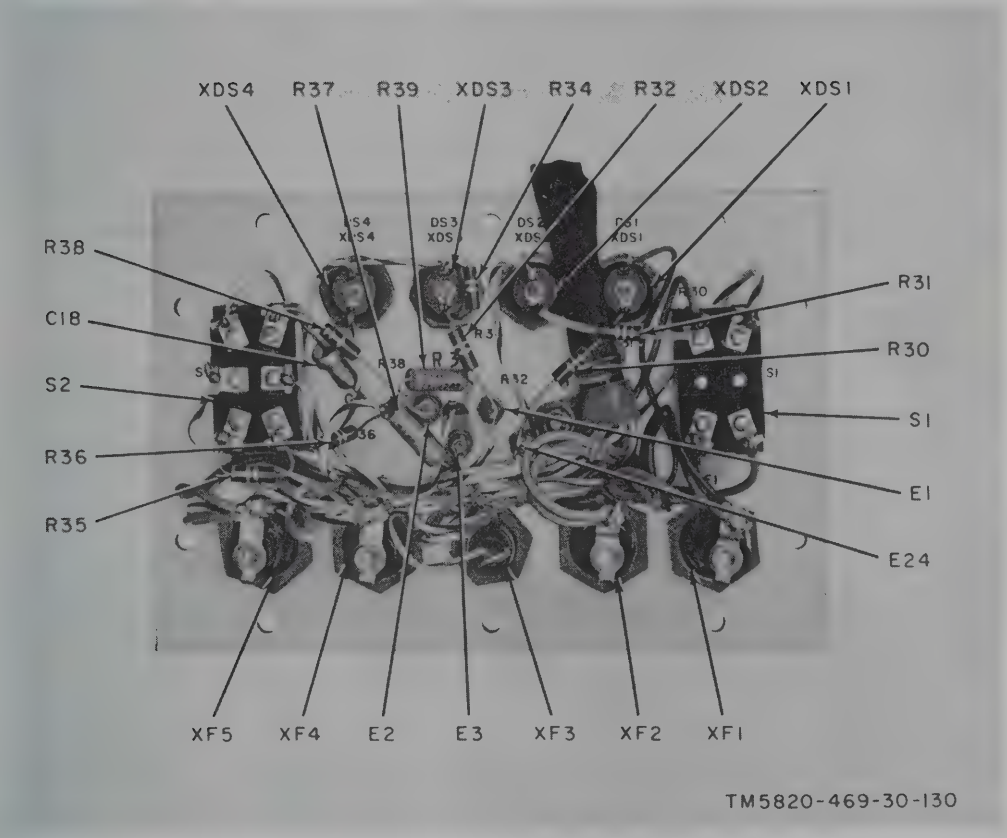


Figure 89. Receive converter power supply, rear view of meter panel.

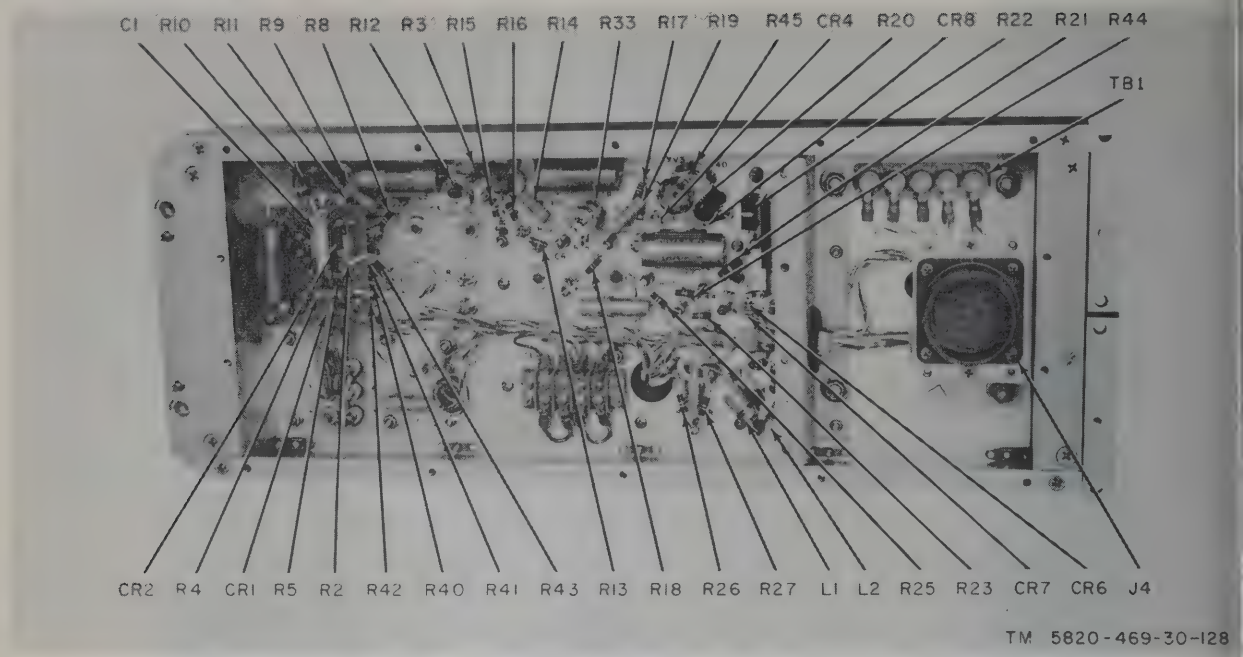


Figure 90. Receive converter power supply, rear view, location of components (part 1 of 2).

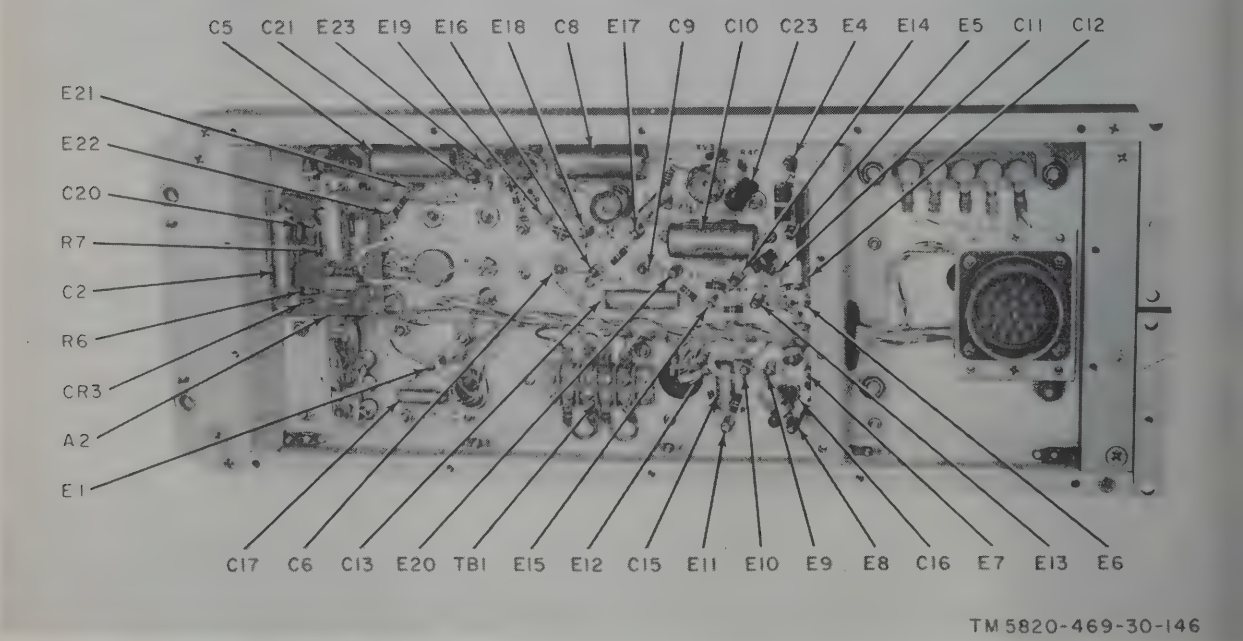


Figure 90. Receive converter power supply, rear view, location of components (part 2 of 2).

Section IV. IF AMPLIFIER TROUBLESHOOTING PROCEDURES

2. General

When trouble has been localized to the IF plifier chassis (para. 239), the next step is isolate the defect to one of the five subas-mblies (fig. 75) that comprise the IF ampli-r assembly. The failure can frequently be olated by signal tracing; that is, by checking e signal level at test points provided on the amplifier subassemblies. Before proceeding, certain that all tube filaments are lighted, d that the IF amplifier power supply is func-oning normally (paras. 259 and 260). If ouble has been localized to one of the sub-semblies within the IF amplifier assembly, oceed direct to the applicable subparagraph paragraph 255 for signal level measure-ents. If the defect has not been localized be-nd the IF amplifier assembly, perform the ocedures given in paragraphs 253, 254, and 5, in the order listed.

3. Test Connections for IF Amplifier Troubleshooting

Follow the instructions given in paragraph of TM 11–5820–469–20 to remove the IF plifier from the rack. Set the IF amplifier a service bench and connect the equipment as ustrated in figure 91. Use the receiver sys-m test cable (item 30, test facilities kit, fig. 0) to connect the IF amplifier and the IF plifier power supply to the test equipment d to the ac source voltage.

4. IF Amplifier Preliminary Test Procedures

a. Connect the IF amplifier as specified in aragraph 253. Unless otherwise specified, gnal Generator AN/URM–48 should be con-cted to J1 (fig. 91) throughout the test pro-dures in this section. Set the AN/URM–48 produce an output frequency of 70 mc. Check e 70-mc setting, using the internal crystal librator. Modulate the 70-mc signal with a 000-cps tone and observe meter M1 (with S1 t to RCVR GAIN 6 position) for an indica-on of the output. Check to see that the AN/ RM–48 frequency setting coincides with the maximum signal level reading. Adjust the input signal level as necessary to keep the M1 meter indication on scale.

b. See that bandwidth control switch S2 is set to 4 KMC. Temporarily remove the signal input to J1 (fig. 91) and carefully adjust RCVR GAIN control R4, on the bandwidth control subassembly, to obtain an indication of 6 on meter M1 with no input signal applied.

Note. A final system readjustment of RCVR GAIN control R4 must be made after the IF amplifier chassis has been reinstalled in the shelter and connected to the receive converter.

c. Before proceeding with the tests in this section, refer to TM 11–1257, covering Signal Generator AN/URM–48, to review the RF loading and level corrections necessary when operating into various loads. The end-of-cable termination box (10 ohms) supplied with the AN/URM–48 must be connected first. Using a 1,000-cps internal frequency modulation, adjust the audio level for a peak frequency deviation of 9 kc, using the self-contained deviation meter on the AN/URM–48. Deviation may also be checked with Modulation Meter ME–57/U.

d. Use Voltmeter, Electronic ME–30B/U and Multimeter ME–26B/U as required to check the various module test jack voltages. Compare each measurement with the typical meter indications in the charts given in paragraph 255.

e. The final 619-ohm terminated audio measurement (para. 257*b* (2) at J4 (rear of main chassis, fig. 91) provides an overall check of the operational condition of the complete IF amplifier. This level can be checked first, if time is limited. Satisfactory measurement at J4, together with checks of the dc measurements at jacks J4, J8, and J3 on bandwidth control subassembly 2A2 (para. 55*c*), indicates that the IF amplifier is functioning normally.

255. IF Amplifier Test Measurements

a. General. Refer to the preliminary procedures listed in paragraph 254 before perform-

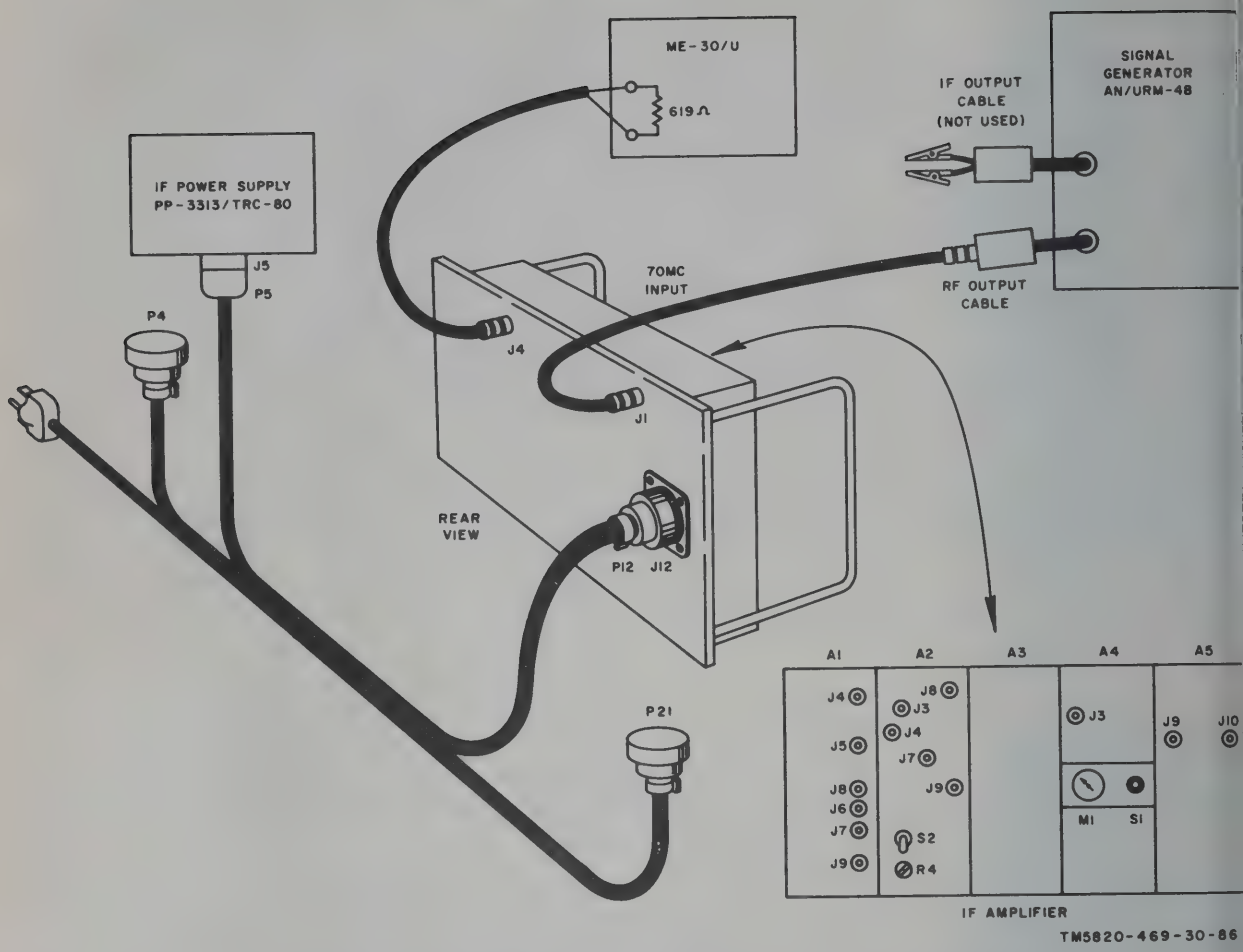


Figure 91. IF amplifier and IF amplifier power supply, test setup.

ing the measurements specified in *b* through *f* below. All AN/URM–48 output levels listed in the charts are the signal levels applied to rear panel input jack J1 (fig. 91). The output dc test measurements are taken at the jacks listed in the *Test point* column. All voltage readings are with respect to ground. Normal readings indicate proper operation over a wide range of input signal levels. If meter indications are abnormal, refer to the voltage and resistance diagram for the defective subassembly and perform measurements on the suspected stages. Reference to the IF amplifier block diagram (fig. 163) and to the complete subassembly schematic diagram will clarify the procedures being performed.

b. Subassembly 2A1, 70-8-Mc Converte
Perform the measurements listed below *wit out* removing subassembly 2A1 from the I amplifier main frame. When voltage and resis ance measurements must be performed (fi 92), use the following procedure to apply ope ating voltages:

(1) Turn off the power on the IF amplifi power supply.

(2) Loosen the four corner-located retai ing screws and remove subassemb 2A1.

(3) Use the IF amplifier subassembly e tender cable (item 22, test faciliti kit, fig. 150) between J1 (fig. 95) a

J7 (fig. 124) on the IF amplifier main frame.

(4) Use two coaxial extender cables (item 25, test facility kit, fig. 150) to connect the signal input to J2 ((1), fig. 94) and the signal output from J3 (fig. 95).

(5) Figures 93, 94, and 95 illustrate the component locations.

Normal test point meter indications (volts dc)

st point	AN/URM-48 output levels			
	No signal	100 uv	1,000 uv	100,000 uv
J4	0	0	0	0.08
J4	0	0	0	0.63
J6	0.4	0.4	0.4	0.68
J7	3.2	3.2	3.3	3.3
J8	4.8	4.8	4.8	4.8
J9	0	0	0	1.85

c. Subassembly 2A2, Bandwidth Control. erform the measurements listed below *with-t* removing the 2A2 from the IF amplifier ain frame. When voltage and resistance meas-rements (fig. 96) must be performed, follow e procedure below to apply operating volt-ges:

(1) Turn off the power on the IF amplifier power supply.

(2) Loosen the four corner-located captive screws and remove subassembly 2A2.

(3) Use the IF amplifier subassembly extender cable (item 22, test facilities kit, fig. 150) between J5 (fig. 98) and J8 (fig. 124) on the main frame.

(4) Use the two coaxial extender cables (item 25, test facilities kit, fig. 150) to connect the signal input to J1 (fig. 98) and the signal output from J2.

(5) Figures 97 through 102 illustrate the component locations.

Normal test point meter indications (volts dc)

est point	AN/URM-48 output levels			
	No signal	100 uv	1,000 uv	100,000 uv
J9	0	0	0	9.0
J7	0	0.1	1.7–2.7	45
J4	0.33	7.0	7.2	7.2
J8	10.0	23	28	35
J3	7.2	26	32	38

d. Subassembly 2A3, 8-Mc IF Amplifier No. 1. Perform the measurement listed below *without* removing the 2A3 from the IF amplifier main frame. When voltage and resistance measurements (fig. 103) must be performed, follow the procedure below:

(1) Turn off the power on the IF amplifier power supply.

(2) Loosen the four corner-located captive screws and remove subassembly 2A3.

(3) Use the IF amplifier subassembly extender cable (item 22, test facilities kit, fig. 150) between J4 (fig. 106) and J9 (fig. 124) on the IF amplifier main frame.

(4) Use the two coaxial extender cables (item 25, test facilities kit, fig. 150) to connect the signal input to J2 (fig. 106) and the signal output from J3.

(5) Figures 104 through 109 illustrate the component locations.

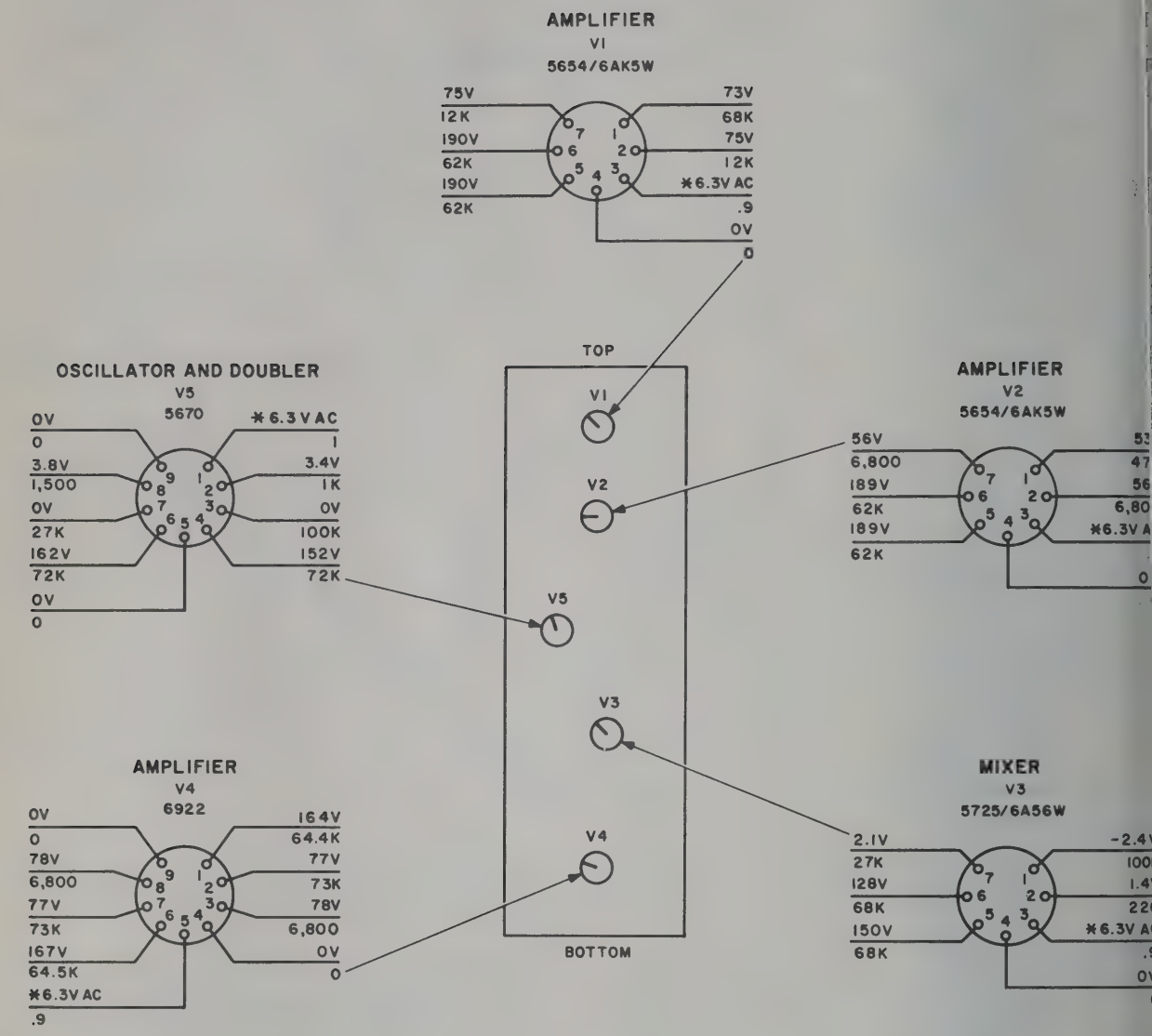
Normal test point meter indications (volts dc)

Test point	AN/URM-48 output levels			
	No signal	100 uv	1,000 uv	100,000 uv
J1	0	2.6	2.8	2.8

e. Subassembly 2A4, 8-Mc IF No. 2. To perform the measurements listed in (2) below proceed as follows:

(1) Turn off the power on the IF power supply and remove the 8-mc IF No. 2 module from the main chassis. Remove the right-hand side panel and reconnect the subassembly, using the IF amplifier module extender cable (item 22, test facilities kit, fig. 150) between J4 (fig. 114) and J10 (fig. 124) on the IF amplifier main frame. Use the two coaxial extender cables (item 25, test facility kit, fig. 150) to connect the signal input to J1 and the signal output from J2 (fig. 113).

(2) Refer to figures 111 through 115 for the component locations.



NOTES:

1. VOLTAGES MEASURED TO GROUND WITH A VTVM WITH ALL UNITS INSTALLED, VOLTAGE APPLIED FROM IF POWER SUPPLY, NO EXTERNAL SIGNAL APPLIED, AND OSCILLATOR OPERATING NORMALLY
2. RESISTANCES MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER
3. VOLTAGE READINGS ABOVE THE LINE, RESISTANCE READINGS BELOW THE LINE
4. FOR RESISTANCE MEASUREMENTS ONLY, REMOVE MODULE FROM CHASSIS

* INDICATES MEASUREMENTS ACROSS FILAMENTS

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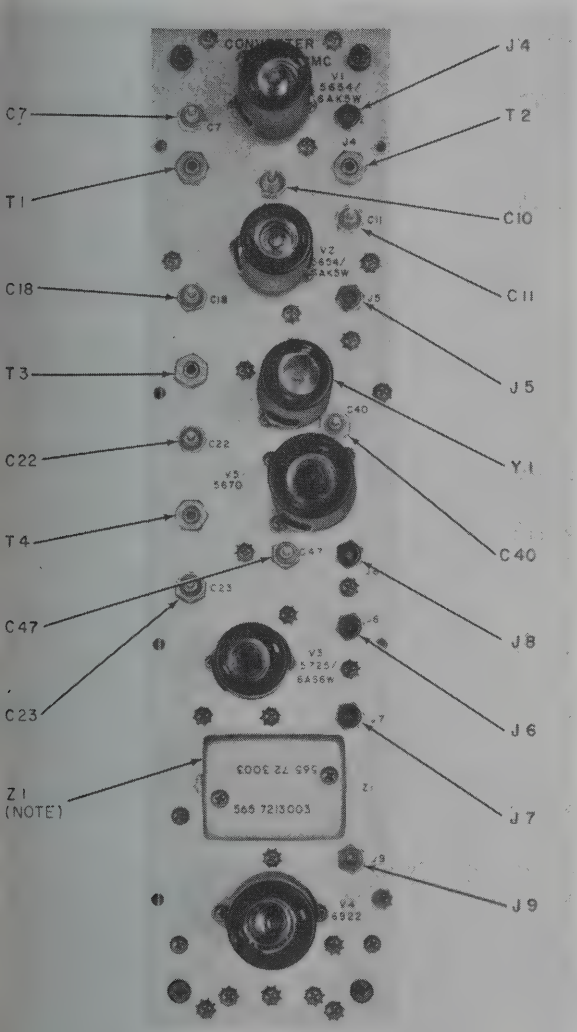
Figure 92. Chassis 2A1, 70-8-mc converter, voltage and resistance diagram.

Normal test point meter indications (volts dc)

Test point	AN/URM–48 output levels			
	No signal	100 *uv*	1,000 *uv*	100,000 *uv*
	5.6	5.8	5.8	5.8
trol arm of .47 at feedthru apacitor C57 g J4, pin 6	5.5 to 10.5	6 to 11	6 to 11	
	9 to 13	18 to 23	18 to 23	



ure 93. Chassis 2A1, 70-8-mc converter, front view.

f. Subassembly 2A5, Discriminator-Combiner. Perform the measurement listed in (5) below *without* removing the 2A5 from the IF amplifier main frame. When voltage and resistance measurements of this subassembly must be performed (fig. 116), use the following procedure to apply the operating voltages:

(1) Turn off the power on the IF amplifier power supply.

(2) Loosen the four corner-located captive screws and remove subassemly 2A5.

(3) Use the IF amplifier subassembly extender cable (item 22, test facilities kit, fig. 150) between J8 (fig. 121) and J11 (fig. 124) on the IF amplifier main frame.

(4) Use two coaxial extender cables (item 25, test facilities kit, fig. 150) to connect the signal input to J1 and the signal output from J4 (fig. 121).

(5) Figures 117 through 122 illustrate the component locations.

Normal test point meter indications (volts dc)

Test point	AN/URM–48 output levels			
	No signal	100 *uv*	1,000 *uv*	100,000 *uv*
J10	7.2	5.7	5.7	5.7

256. Shaper and Combiner Control Voltage Measurement

A check of the combiner-control voltage response to input signal level changes serves as a performance check of 70-8-mc converter subassembly 2A1, bandwidth control 2A2, and 8-mc IF subassemblies 2A3 and 2A4. Use the following procedure:

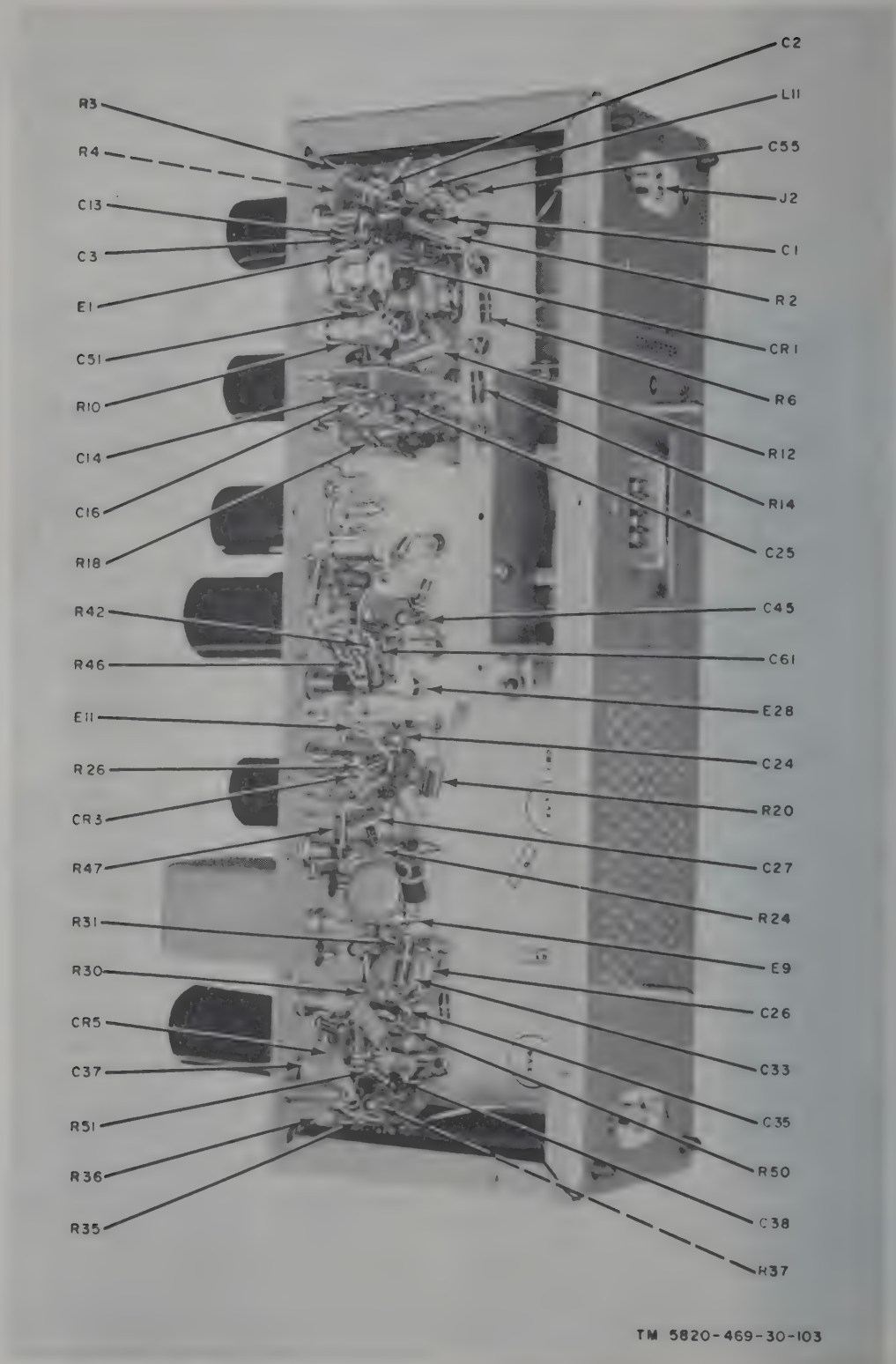


Figure 94. Chassis 2A1, 70-8-mc converter, right side view (part 1 of 2).

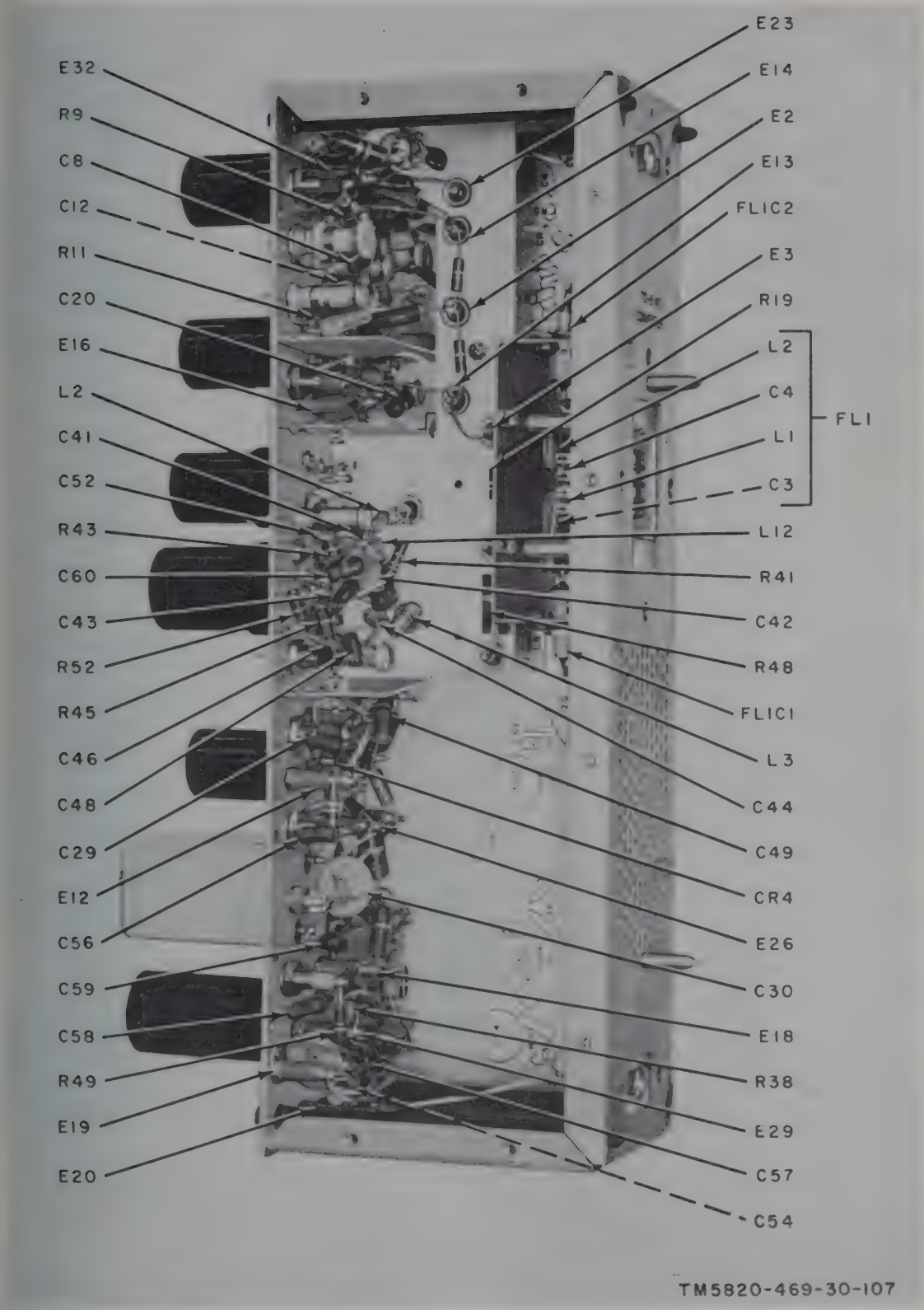


Figure 94. Chassis 2A1, 70-8-mc converter, right side view (part 2 of 2).

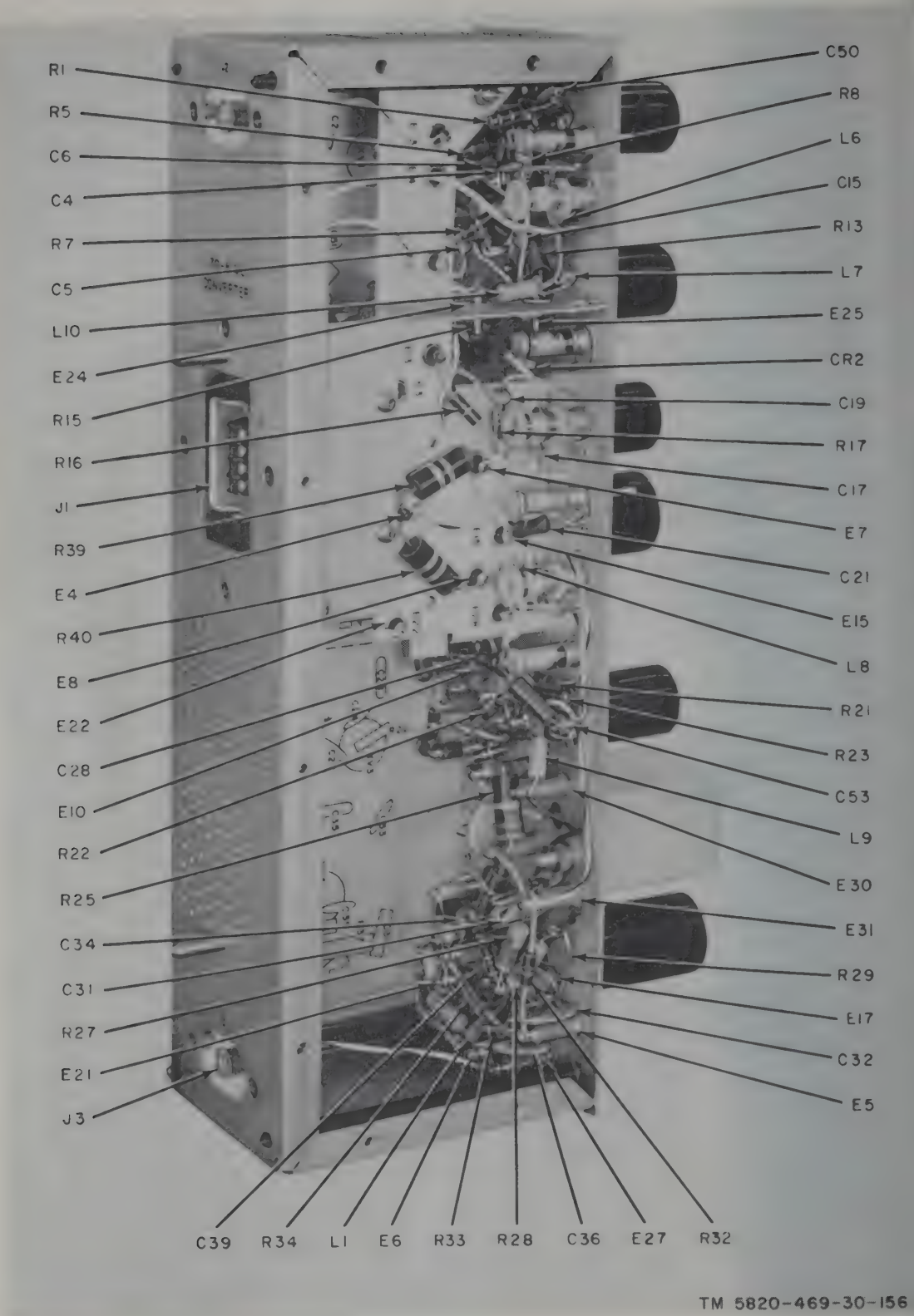


Figure 95. Chassis 2A1, 70-8-mc converter, left side view.

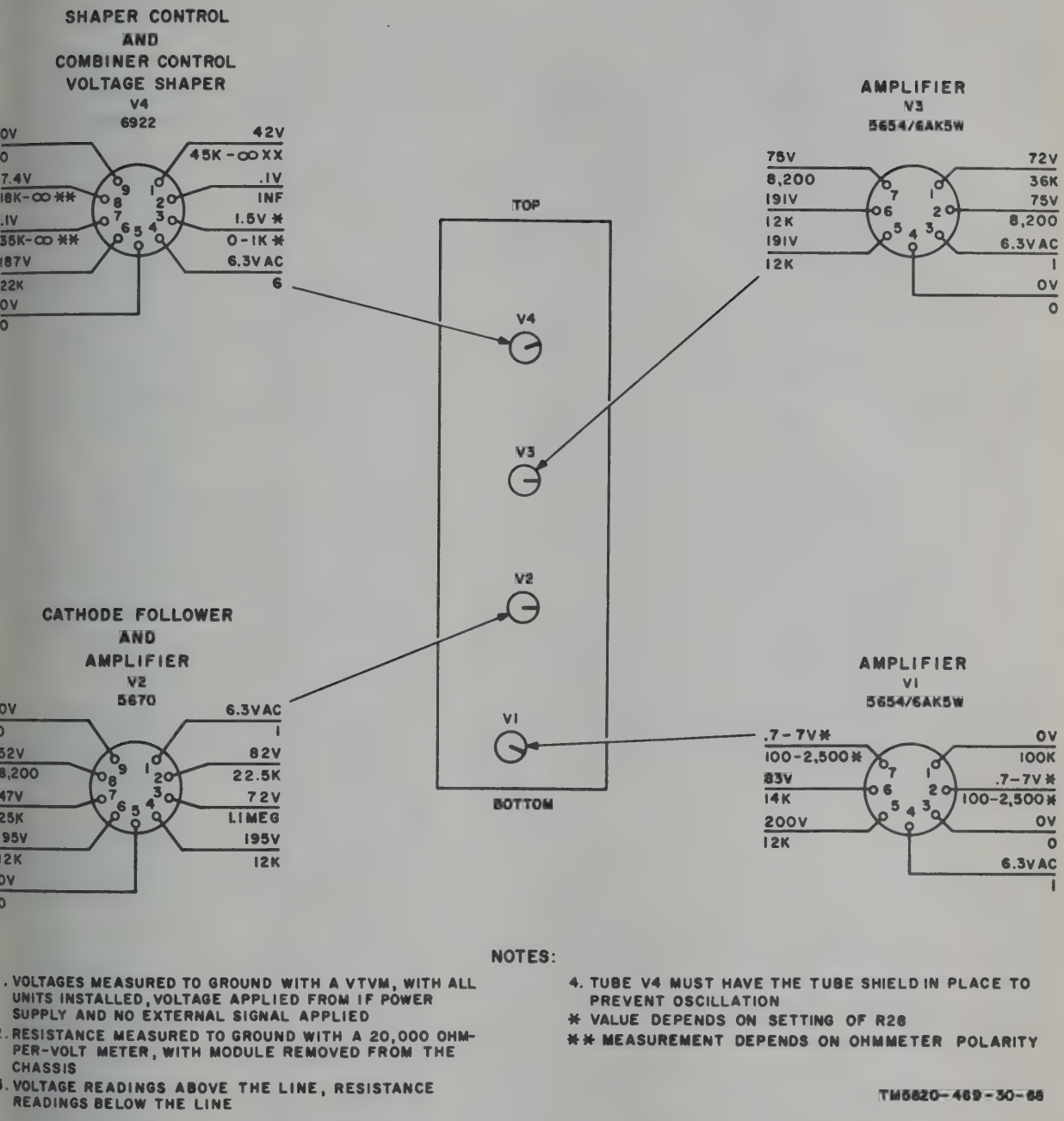


Figure 96. Chassis 2A2, bandwidth control, voltage and resistance diagram.

a. Connect the IF amplifier, the IF amplifier wer supply, the ME–30B/U and the AN/ M–48, using the receiver system test cable em 30, test facilities kit, fig. 150) as shown figure 91.

b. Temporarily disconnect the AN/URM–48 and carefully adjust RCVR GAIN control R4 for an indication of 6 on meter M1 with no input signal applied.

c. Adjust the AN/URM–48 for 70 mc at a

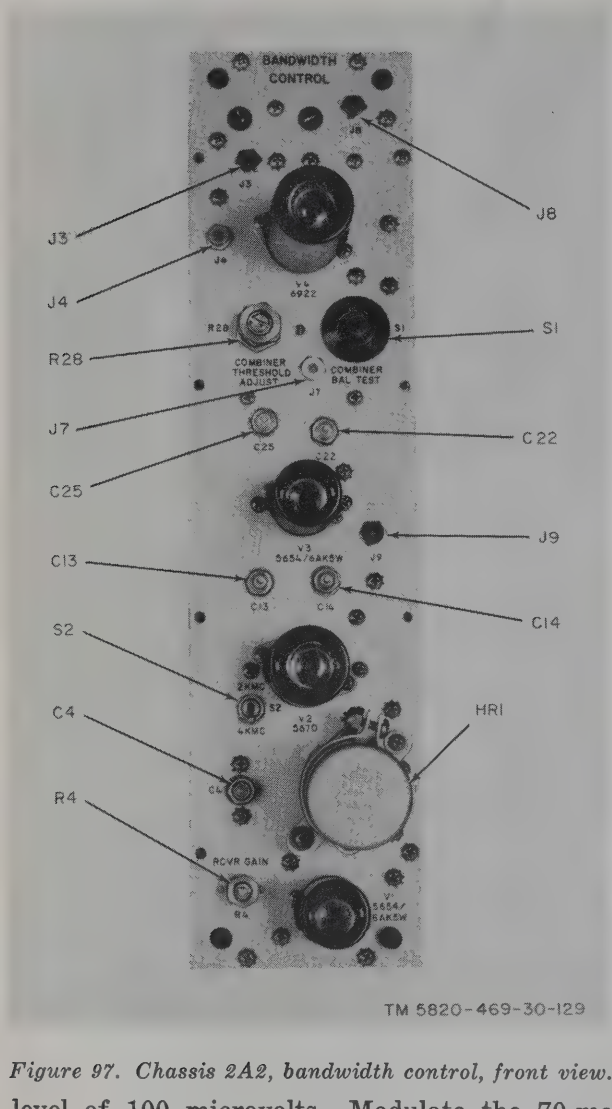


Figure 97. Chassis 2A2, bandwidth control, front view.

level of 100 microvolts. Modulate the 70-mc signal with a 1,000-cps tone. Adjust the frequency, if necessary, to obtain maximum dc indications on the ME–26B/U at test points J3 and J4 (fig. 97) of bandwidth control subassembly 2A2.

d. With AN/URM–48 inputs of 0, 100, an 1,000 microvolts, check for the dc voltage at th test points on the 2A5 (fig. 121) as listed be low:

257. Discriminator-Combiner 2A5 Audio and Signal-Noise Measurements

a. Test Setup. Use the same test setup a specified in paragraph 256*a*.

b. Audio Output Level Measurement.

(1) Set the AN/URM–48 as follows:
(*a*) Output frequency: 70 mc.
(*b*) Output level: 100 microvolts.
(*c*) Modulation: 1,000 cps, 9-kc pea deviation. This adjustment may b checked externally with the ME 57/U.

(2) Monitor the output at J4 (fig. 91 using meter ME–30B/U. Termina the meter input, using a BNC 619-oh resistive termination (item 21, te facilities kit, fig. 150) connected to th GR to BNC adapter (item 12, te facilities kit, fig. 150).

(3) The output level should measure —1 dbm (194 millivolts); if it does no readjust OUTPUT LEVEL contr R31.

(4) If adjustment of R31 does not produ the required indication, refer to figu 116 and perform the voltage and r sistance measurements.

c. Signal-Noise Ratio Measurement.

(1) Obtain the measurement given paragraph *b*(3) above.

Test point	Circuit	DC voltage		
		0 *uv* input	100 *uv* input	1,000 *uv* input
J3	Combiner-control output voltage.	6–9	23–28	29–34
J4	Shapter input.	0.1–0.5	3–7	3–7
J8	Combiner-control voltage from 8-mc IF amplifier No. 2.	8–12	20–24	27–30

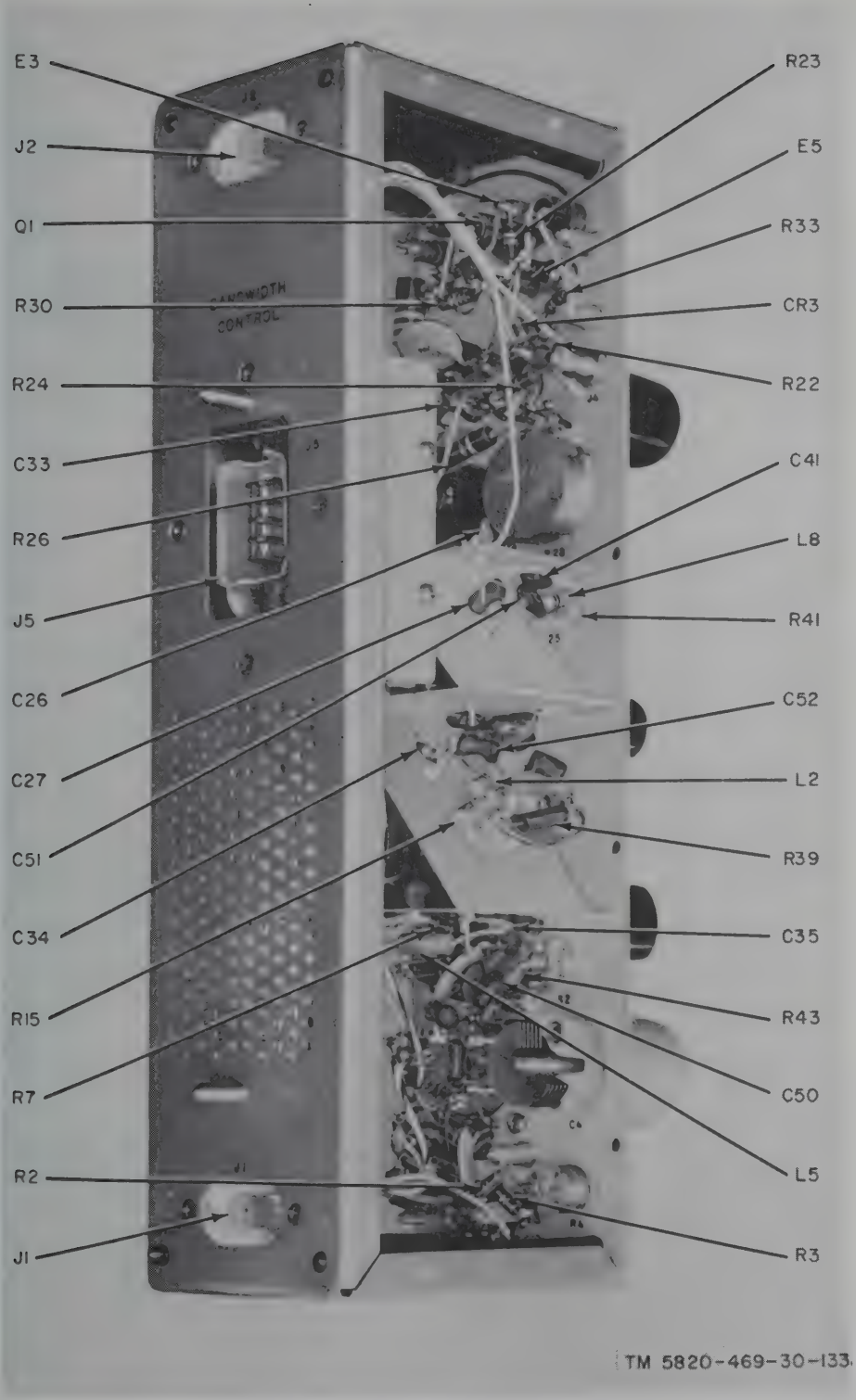


Figure 98. Chassis 2A2, bandwidth control, left side, oblique view.

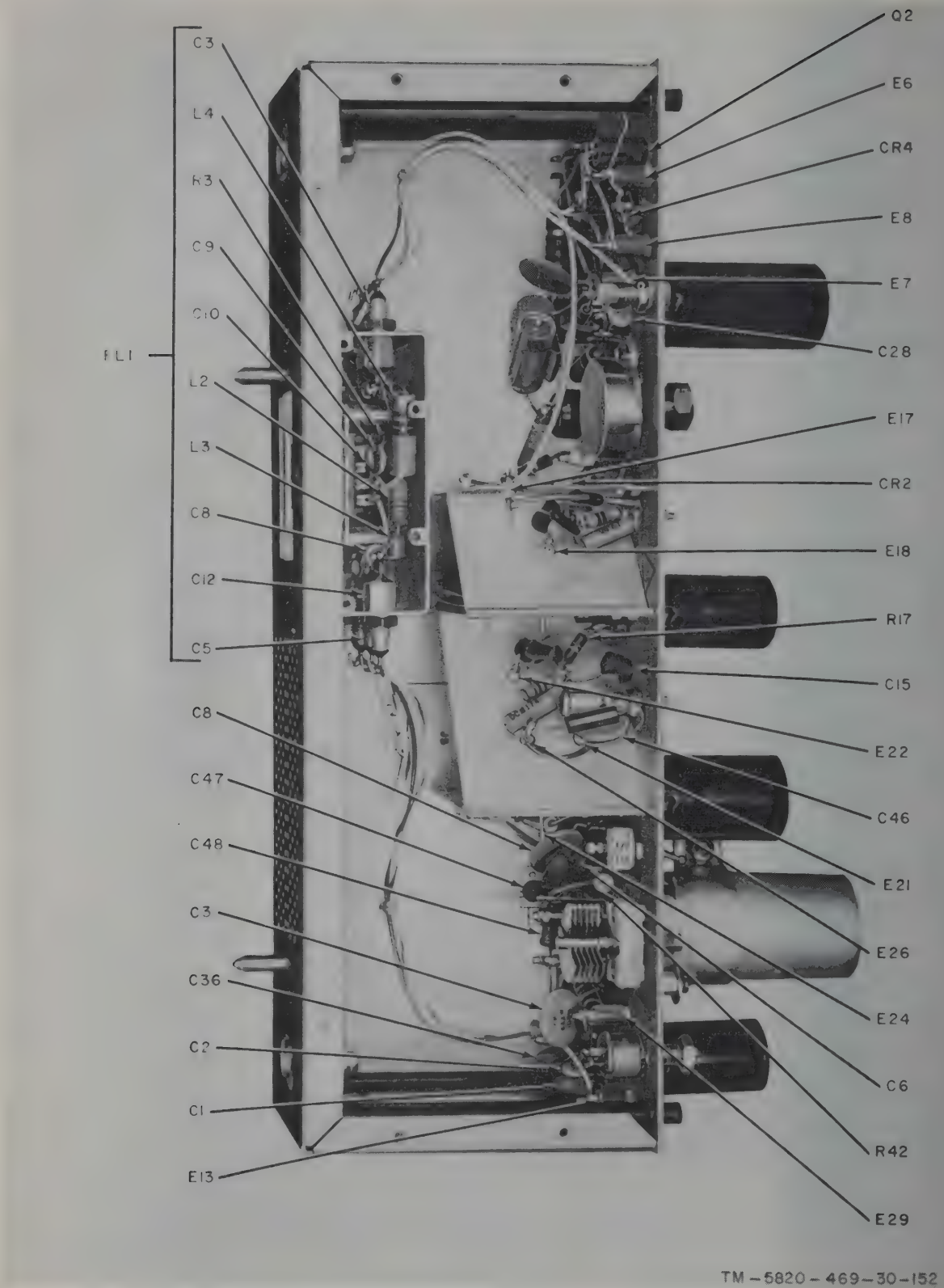


Figure 99. Chassis 2A2, bandwidth control, left side view.

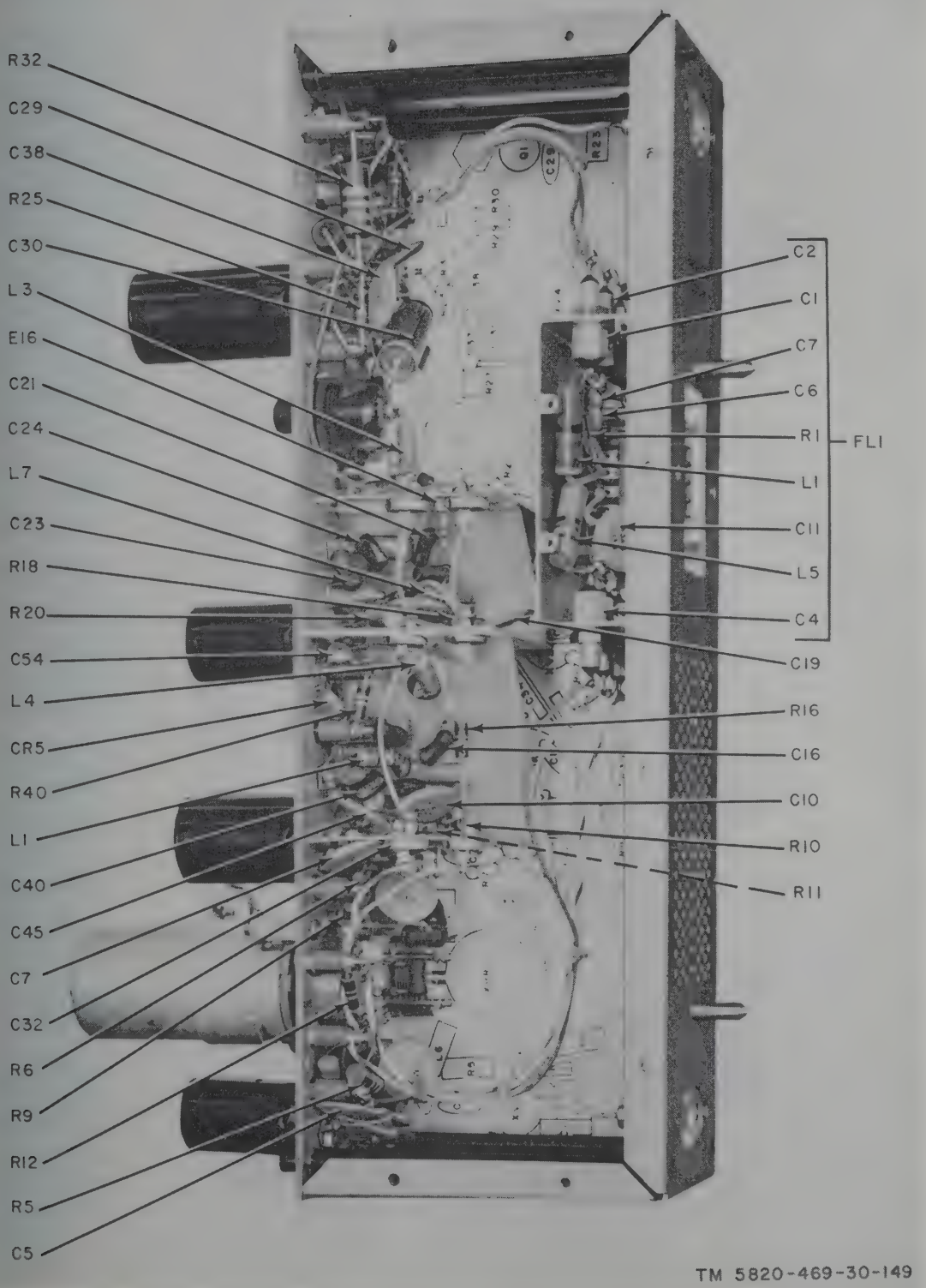


Figure 100. Chassis 2A2, bandwidth control, right side view.

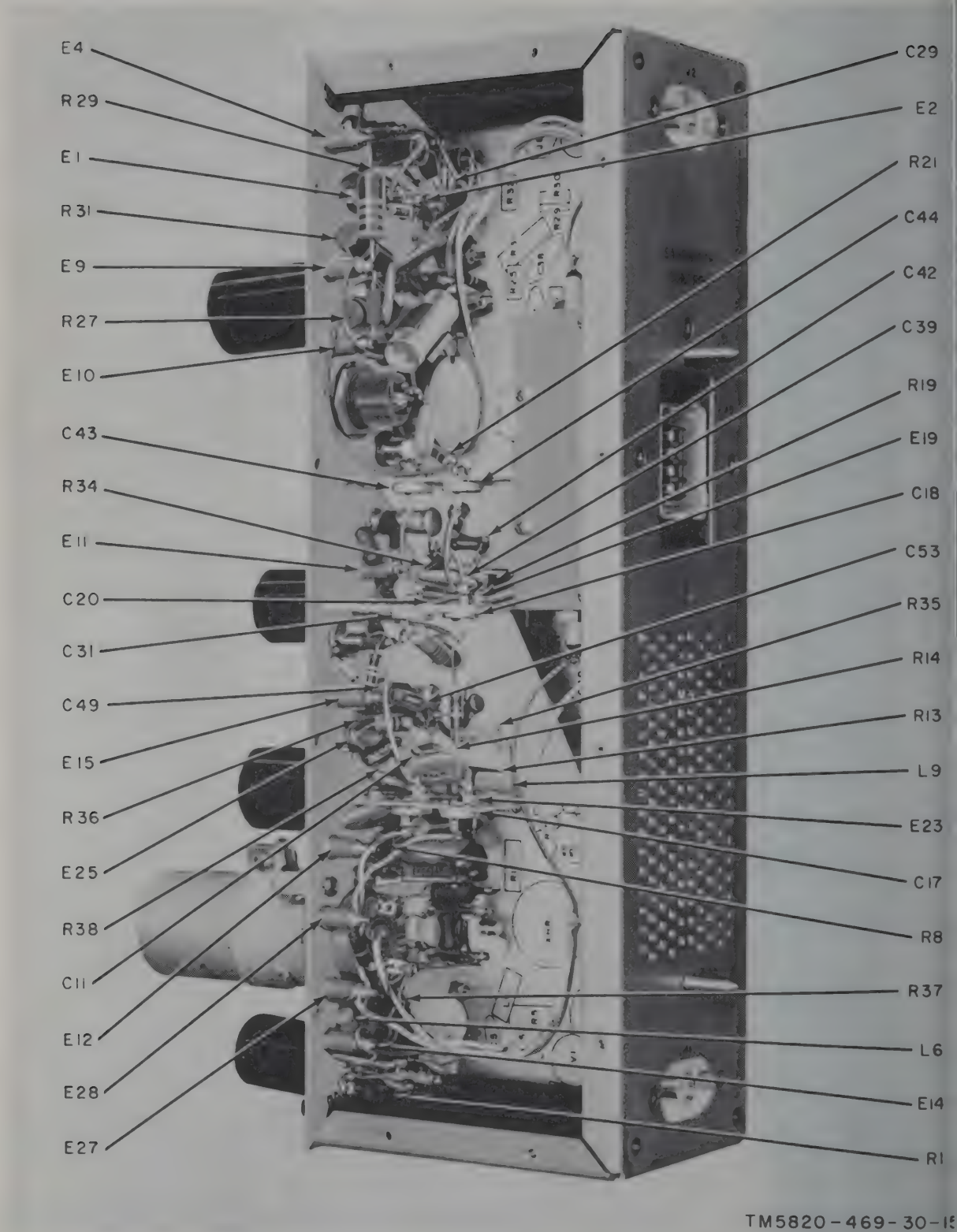


Figure 101. Chassis 2A2, bandwidth control, right side, oblique view.

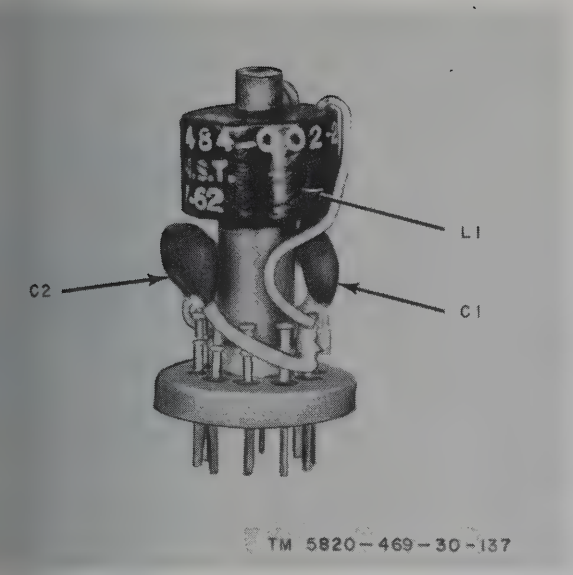


Figure 102. Heater HR1, cover removed (part of bandwidth control chassis 2A2), location of components.

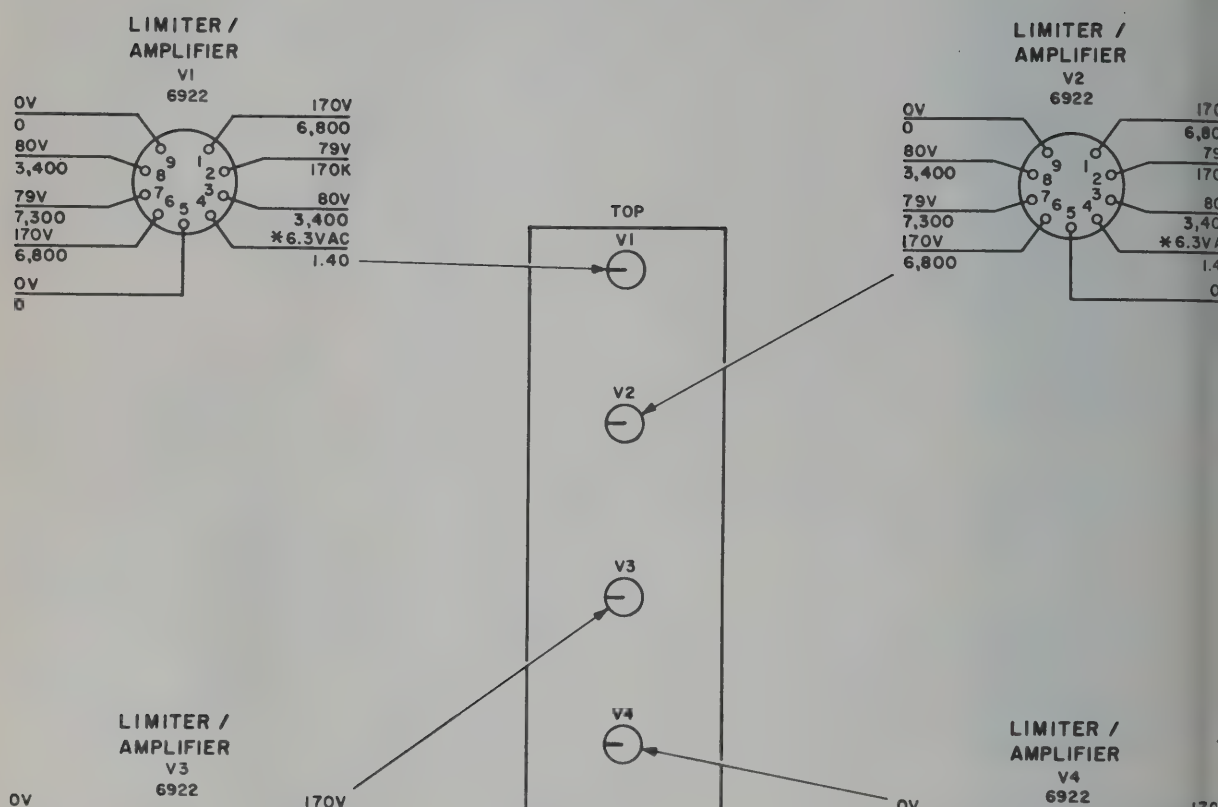
(2) Turn the modulation switch on the AN/URM–48 to the OFF position.

(3) Measure the unmodulated carrier noise level on meter ME–30B/U. This level should be at least 37db below the reference reading obtained in (1) above (—49 dbm or lower).

(4) If the noise measurement is higher than specified in (3) above, check for noisy tubes or a misadjustment of COMBINER BALANCE control R27, COMBINER VOLTAGE SETTING control R47, or COMBINER THRESHOLD ADJUST control R28. Refer to paragraph 298 for the adjustment procedures.

258. Combiner Voltage Check

Figure 190 shows that diodes CR1 through CR4 in 8-mc IF No. 1 subassembly, and diodes CR1, CR4, CR7 and CR8 in 8-mc IF No. 2 form a series circuit. A voltage check from one diode to the next (starting with CR1 in 8-mc IF amplifier No. 1 subassembly 2A3) should indicate a progressive *increase* in voltage. Any sudden discontinuity in these increasing levels indicates a failure in the vacuum tube associated with the diode in question. Voltage and resistance measurements should be performed in this stage to locate the defective part.



NOTES:

1. VOLTAGES MEASURED TO GROUND WITH A VTVM, WITH ALL UNITS INSTALLED, VOLTAGE APPLIED FROM IF POWER SUPPLY, AND NO EXTERNAL SIGNAL APPLIED
2. RESISTANCE MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER
3. VOLTAGE READINGS ABOVE THE LINE, RESISTANCE READINGS BELOW THE LINE
4. FOR RESISTANCE MEASUREMENTS ONLY, DISCONNECT AL EXTERNAL PLUGS

* INDICATES MEASUREMENTS ACROSS FILAMENTS

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Figure 103. Chassis 2A3, 8-mc IF amplifier No. 1, voltage and resistance diagram.

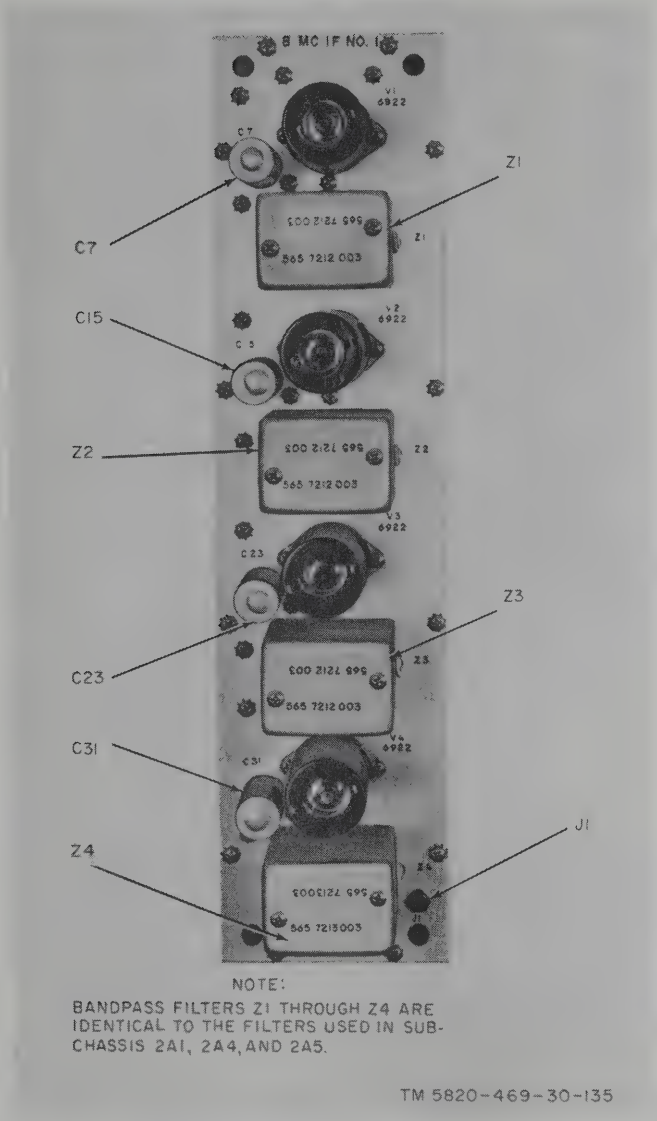


Figure 104. Chassis 2A3, 8-mc IF amplifier No. 1, top view.

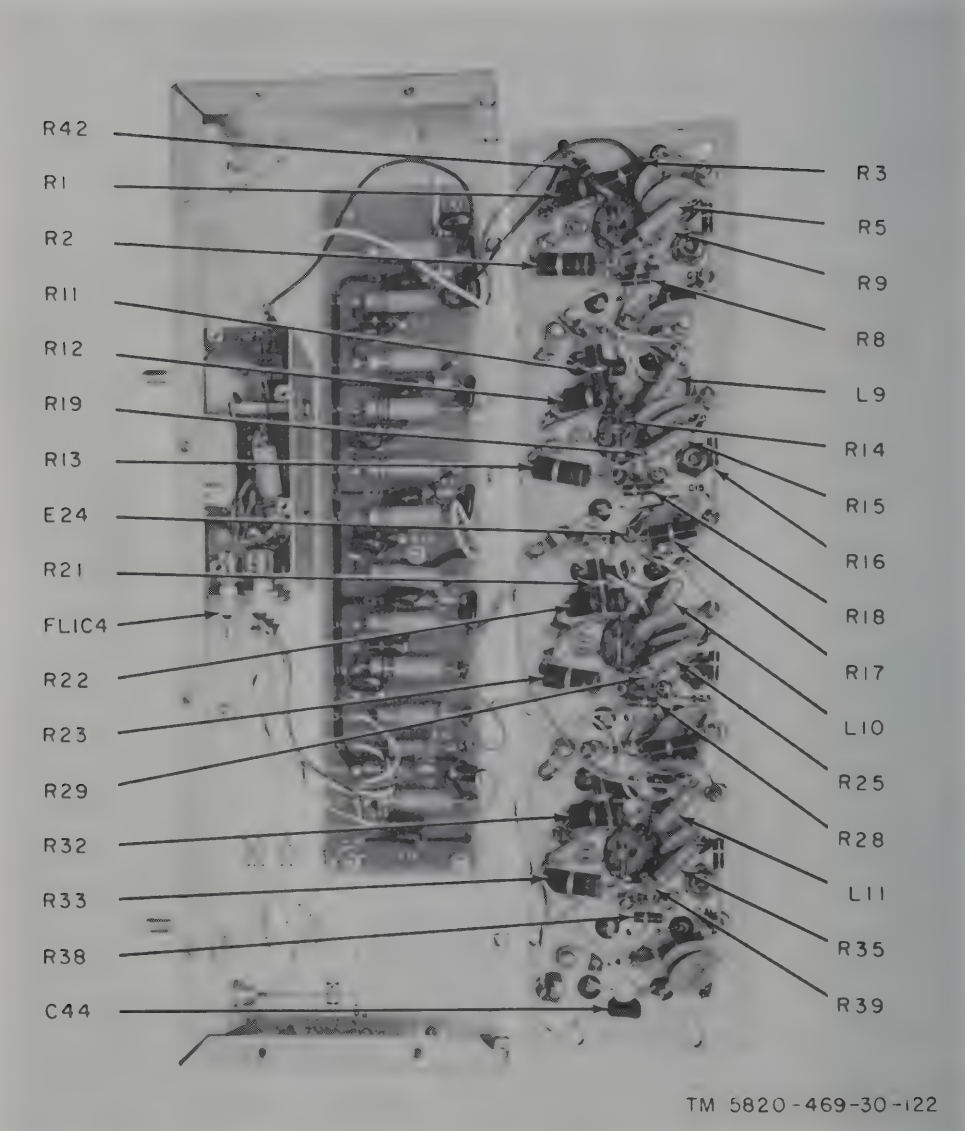


Figure 105. Chassis 2A3, 8-mc IF amplifier No. 1, left side view, top panel unhinged.

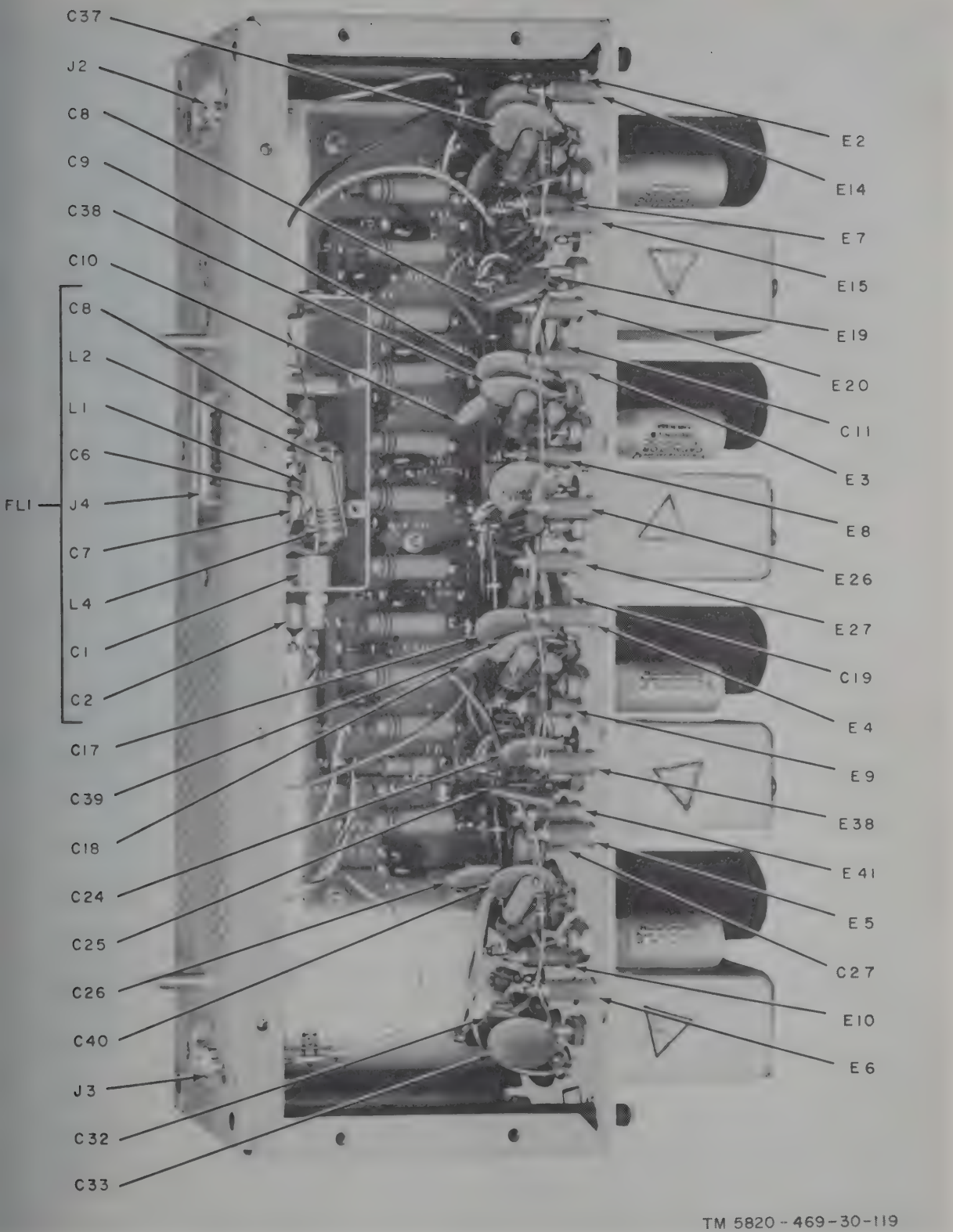


Figure 106. Chassis 2A3, 8-mc IF amplifier No. 1, left side view.

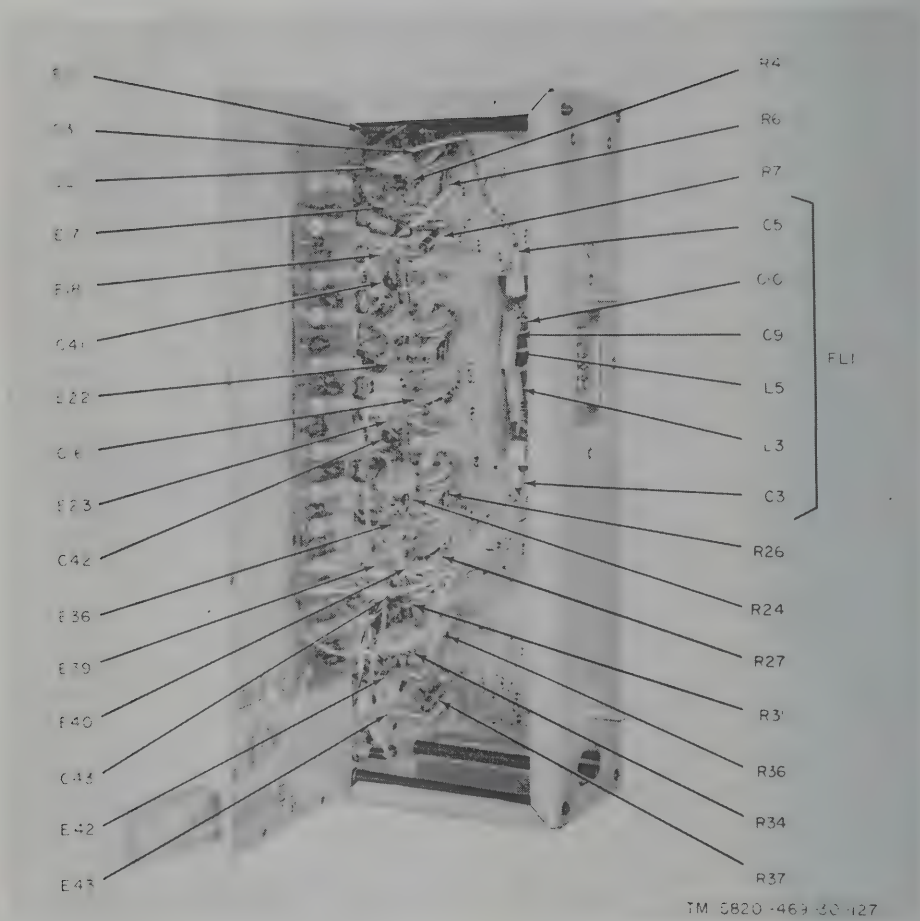
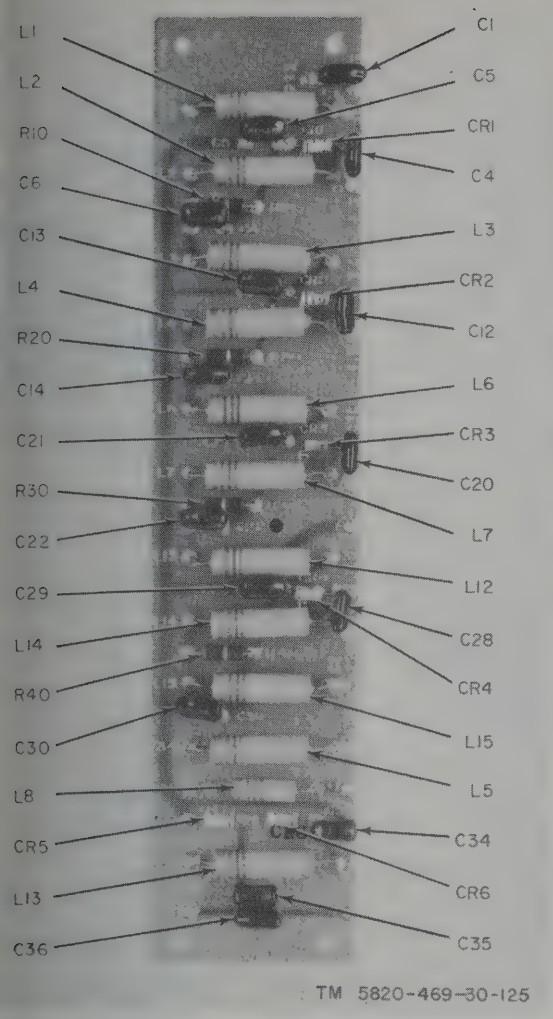


Figure 107. Chassis 2A3, 8-mc IF amplifier No. 1, right side view.



ure 108. Chassis 2A3, 8-mc IF amplifier No. 1, component board.

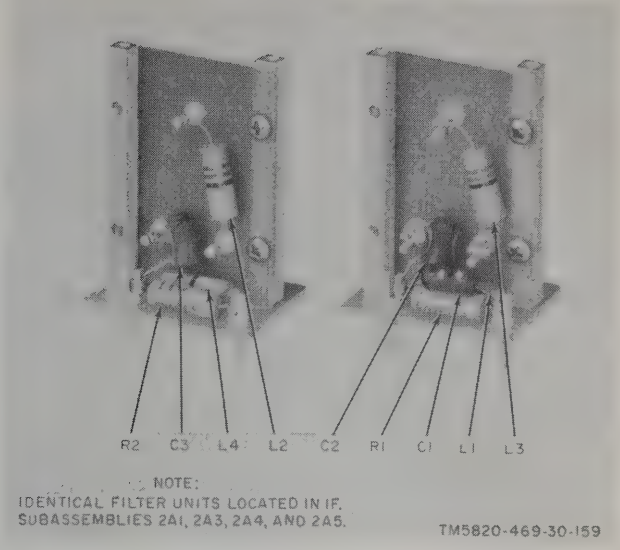


Figure 109. Bandpass filter unit Z1 8-mc bandpass filter, (identical units located in chassis 2A1, 2A3, 2A4, and 2A5).

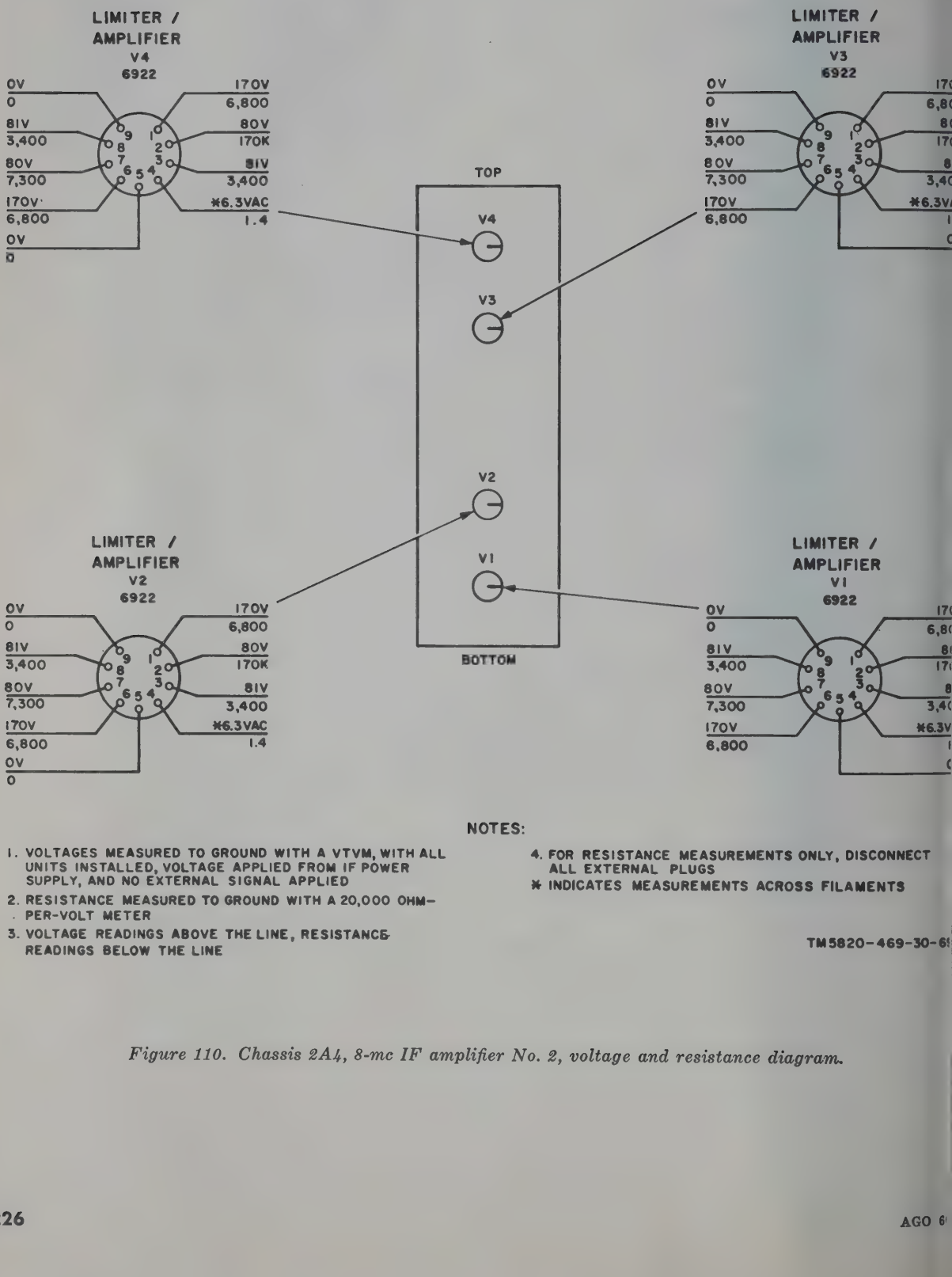

LIMITER / AMPLIFIER V4 6922
0V 0
81V 3,400
80V 7,300
170V 6,800
0V 0
170V 6,800
80V 170K
81V 3,400
*6.3VAC 1.4
LIMITER / AMPLIFIER V3 6922
LIMITER / AMPLIFIER V2 6922
LIMITER / AMPLIFIER V1 6922
TOP
V4
V3
V2
V1
BOTTOM
NOTES:
1. VOLTAGES MEASURED TO GROUND WITH A VTVM, WITH ALL UNITS INSTALLED, VOLTAGE APPLIED FROM IF POWER SUPPLY, AND NO EXTERNAL SIGNAL APPLIED
2. RESISTANCE MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER
3. VOLTAGE READINGS ABOVE THE LINE, RESISTANCE READINGS BELOW THE LINE
4. FOR RESISTANCE MEASUREMENTS ONLY, DISCONNECT ALL EXTERNAL PLUGS
* INDICATES MEASUREMENTS ACROSS FILAMENTS
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Figure 110. Chassis 2A4, 8-mc IF amplifier No. 2, voltage and resistance diagram.

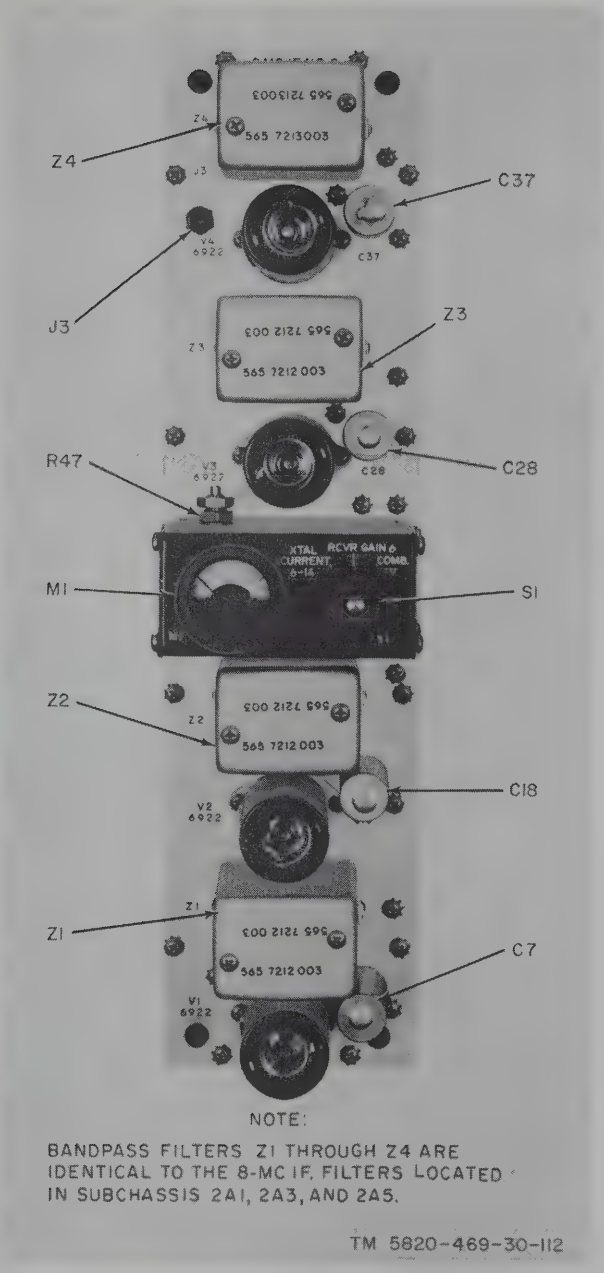


Figure 111. Chassis 2A4, 8-mc IF amplifier No. 2, front view.

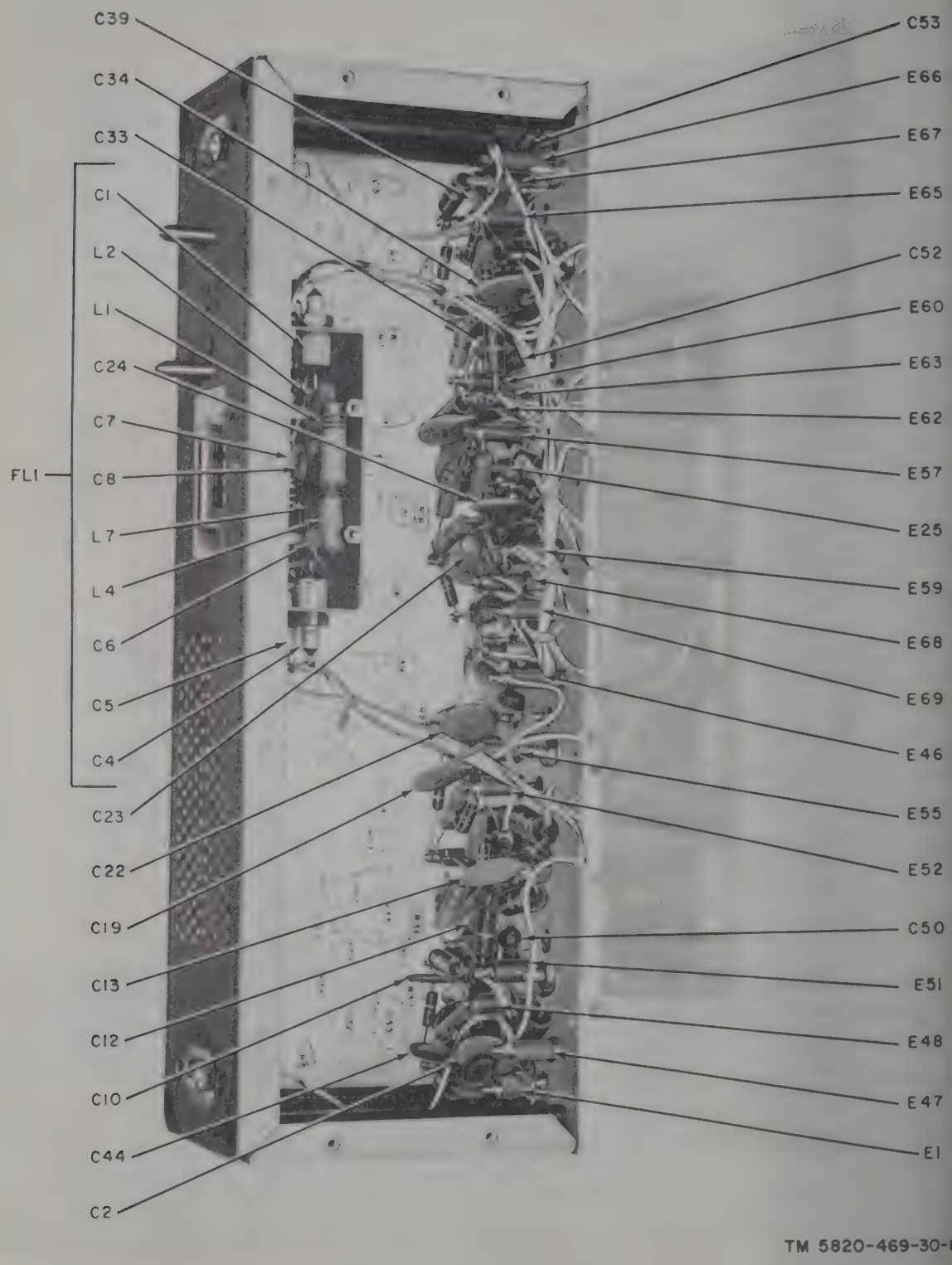


Figure 112. Chassis 2A4, 8-mc IF amplifier No. 2, left side view.

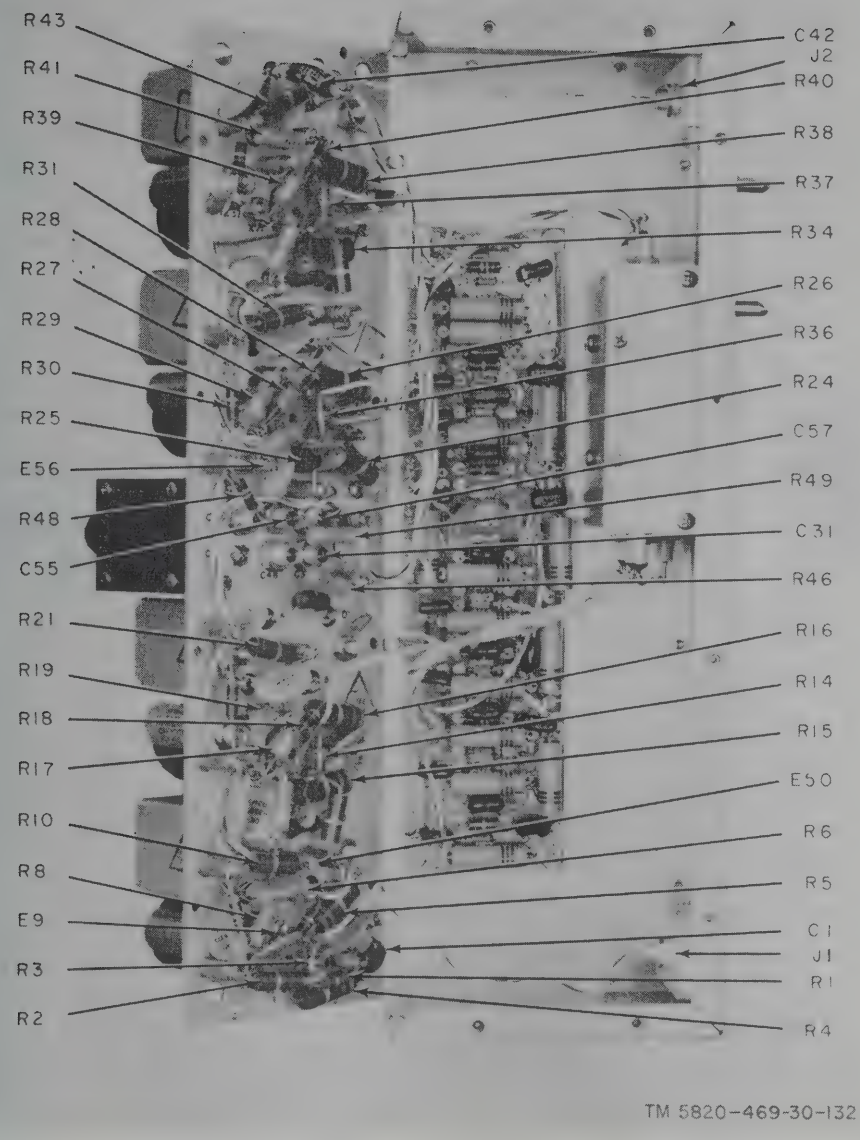


Figure 113. Chassis 2A4, 8-mc IF amplifier No. 2, right side view, top unhinged (part 1 of 2).

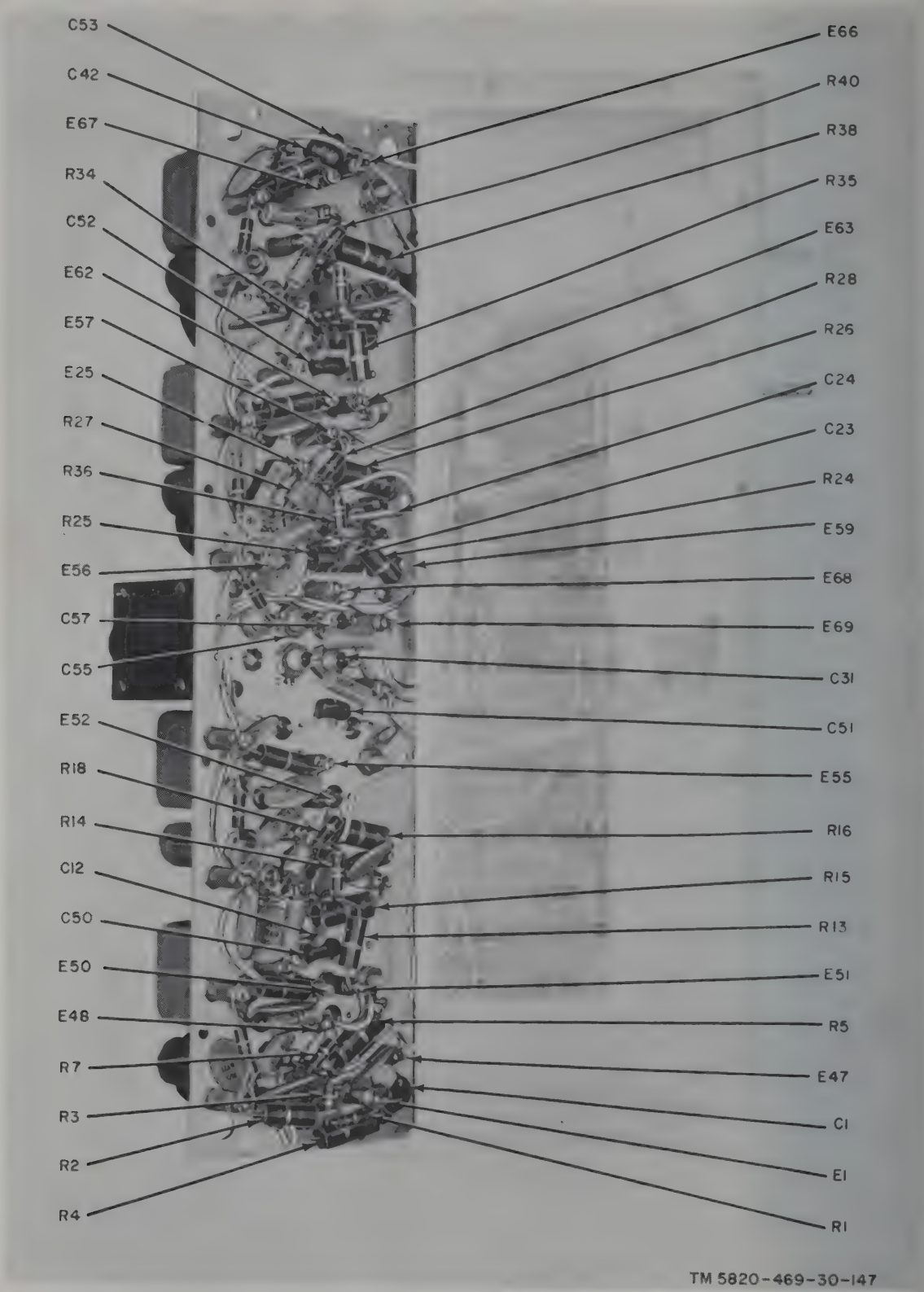


Figure 113. Chassis 2A4, 8-mc IF amplifier No. 2, right side view, top unhinged (part 2 of 2).

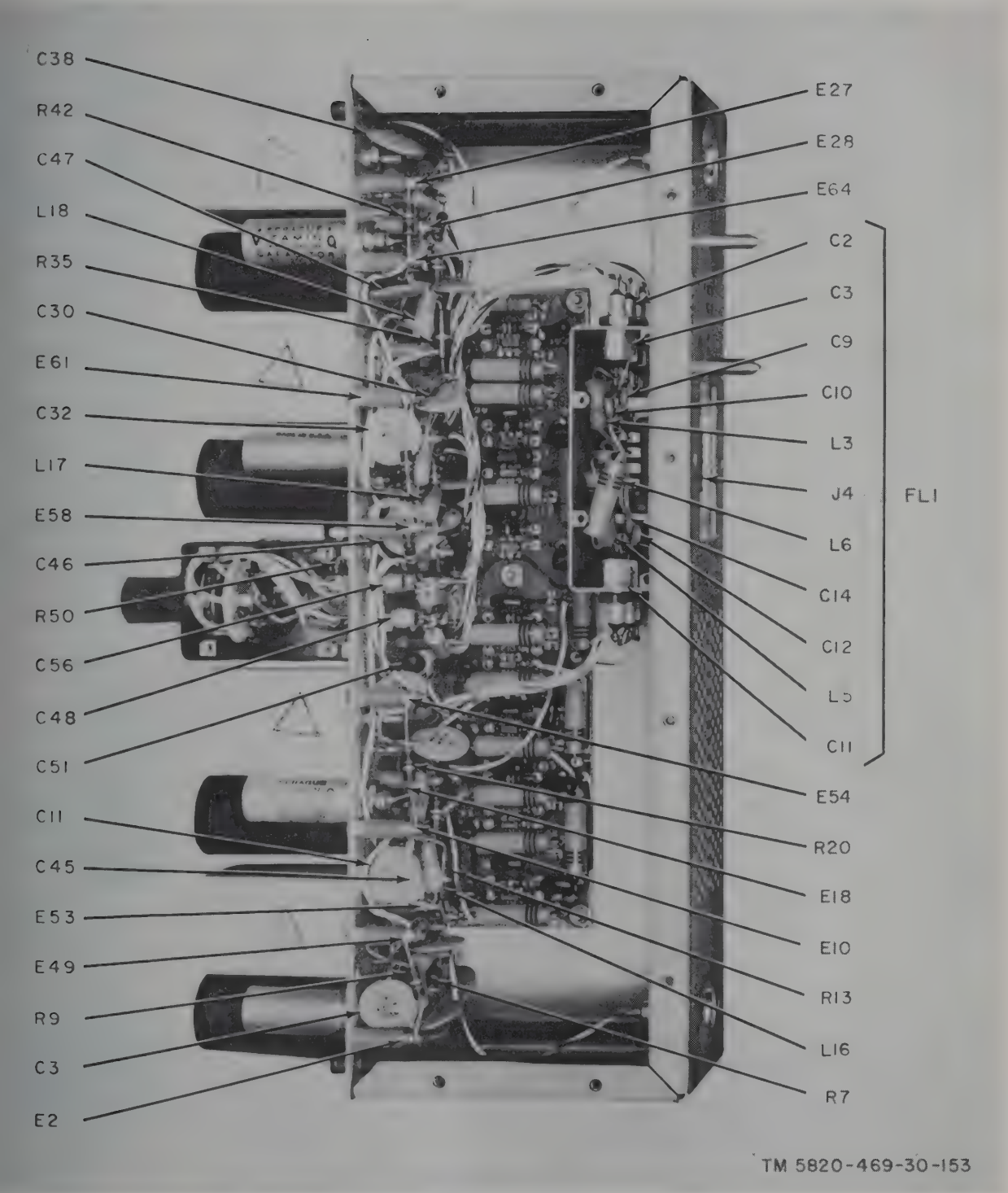


Figure 114. Chassis 2A4, 8-mc IF amplifier No. 2, right side view.

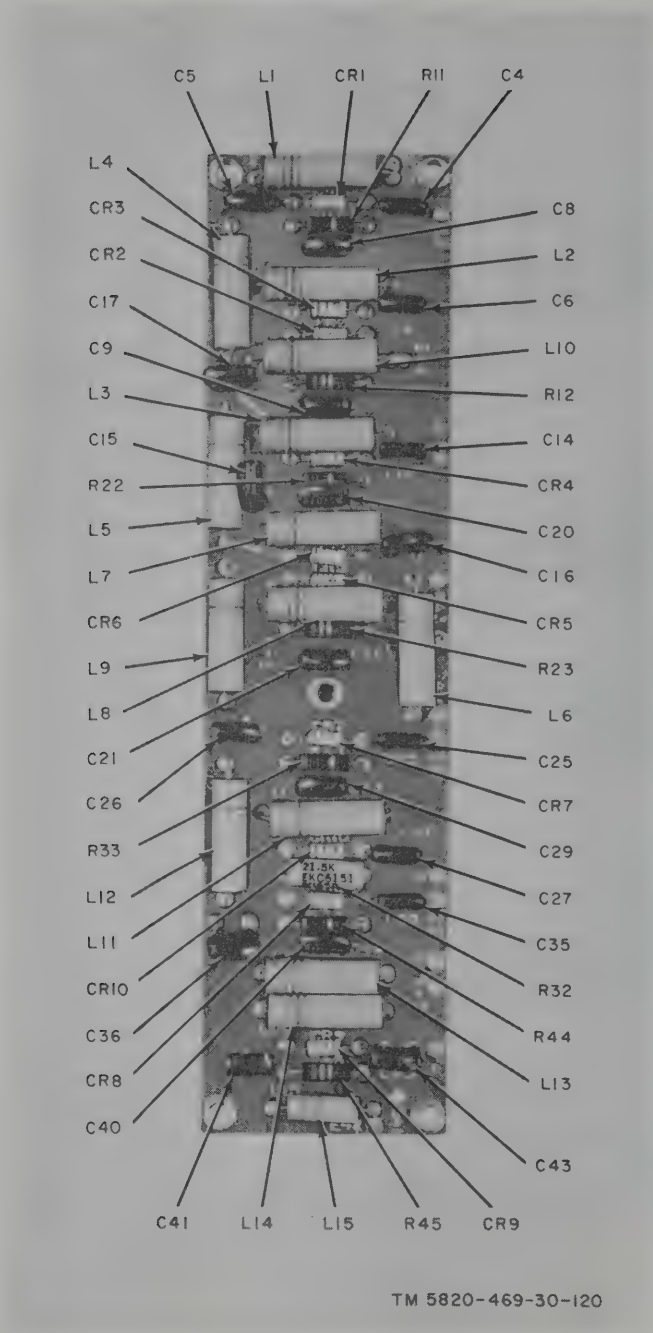
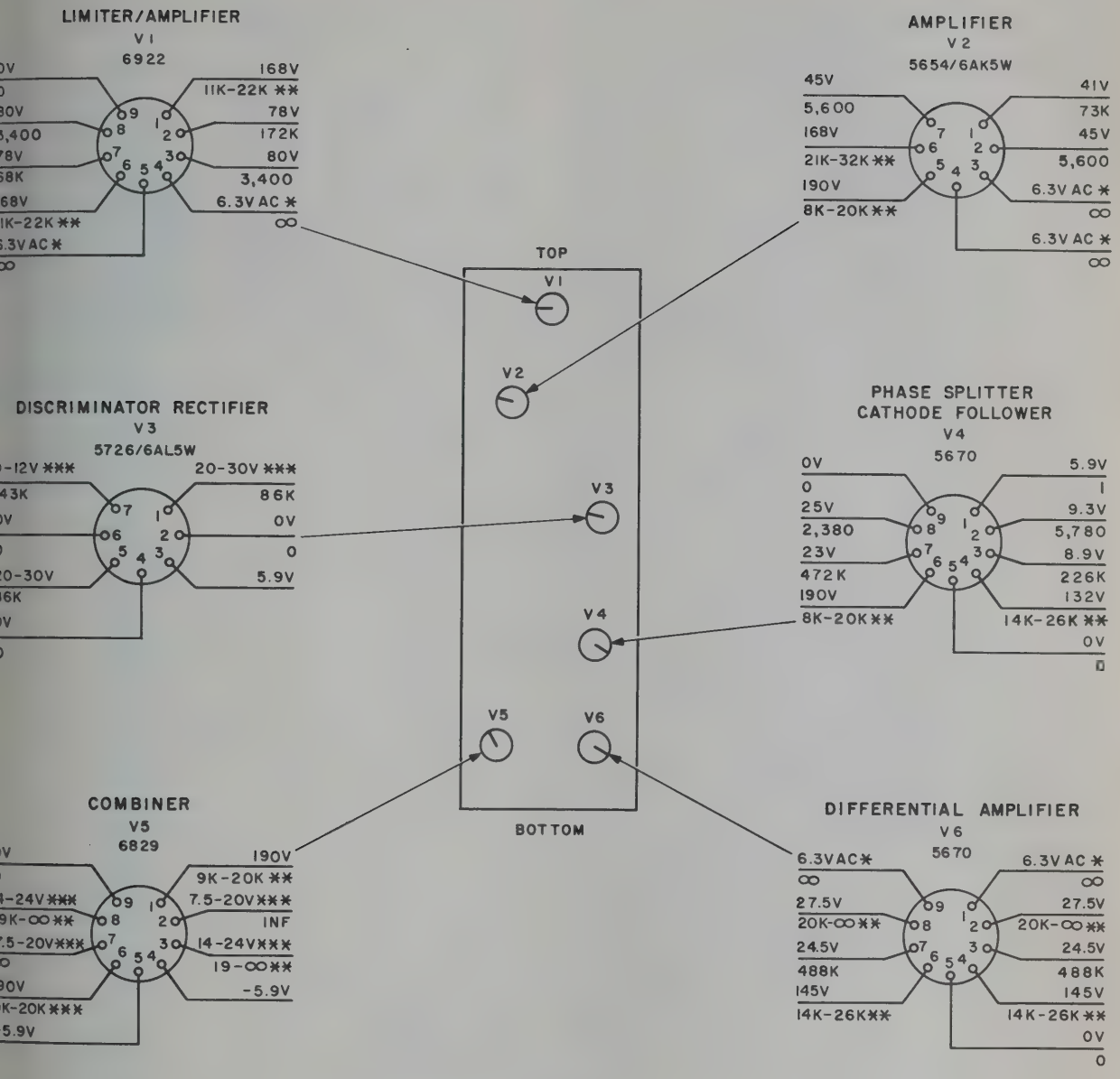


Figure 115. Chassis 2A4, 8-mc IF No. 2, component board.



NOTES:

1. VOLTAGES MEASURED TO GROUND WITH A VTVM, WITH ALL UNITS INSTALLED, VOLTAGE APPLIED FROM I F POWER SUPPLY, AND NO EXTERNAL SIGNAL APPLIED
2. RESISTANCE MEASURED TO GROUND WITH A 20,000 OHM-PER-VOLT METER
3. VOLTAGE AND RESISTANCE MEASUREMENTS TAKEN WITH R 31 FULLY CLOCKWISE
4. VOLTAGE READINGS ABOVE THE LINE, RESISTANCE READINGS BELOW THE LINE
5. FOR RESISTANCE MEASUREMENTS ONLY, REMOVE MODULE FROM CHASSIS

* INDICATES MEASUREMENTS ACROSS FILAMENTS
** MEASUREMENTS DEPEND ON OHMMETER POLARITY
*** MEASUREMENT DEPENDS UPON IF AMPLIFIER GAIN AND DISCRIMINATOR TUNING

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Figure 116. Chassis 2A5, discriminator-combiner, voltage and resistance diagram.

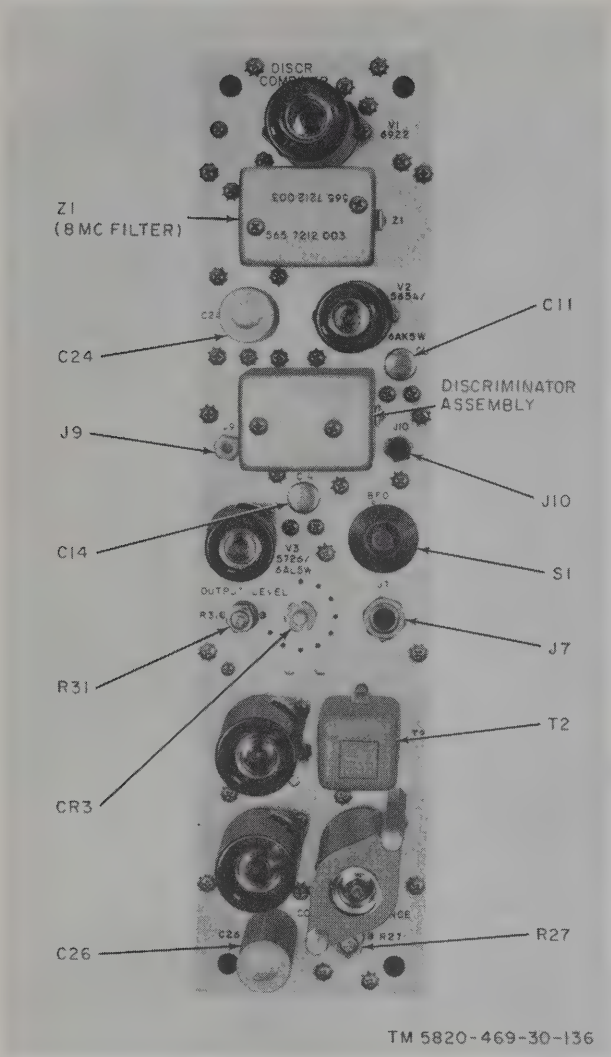


Figure 117. Chassis 2A5, discriminator-combiner, top view.

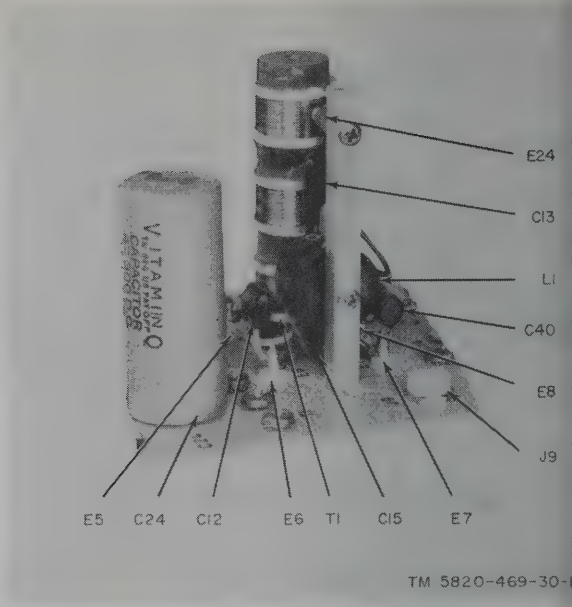


Figure 118. Discriminator-combiner assembly, part discriminator-combiner assembly 2A5, location of components.

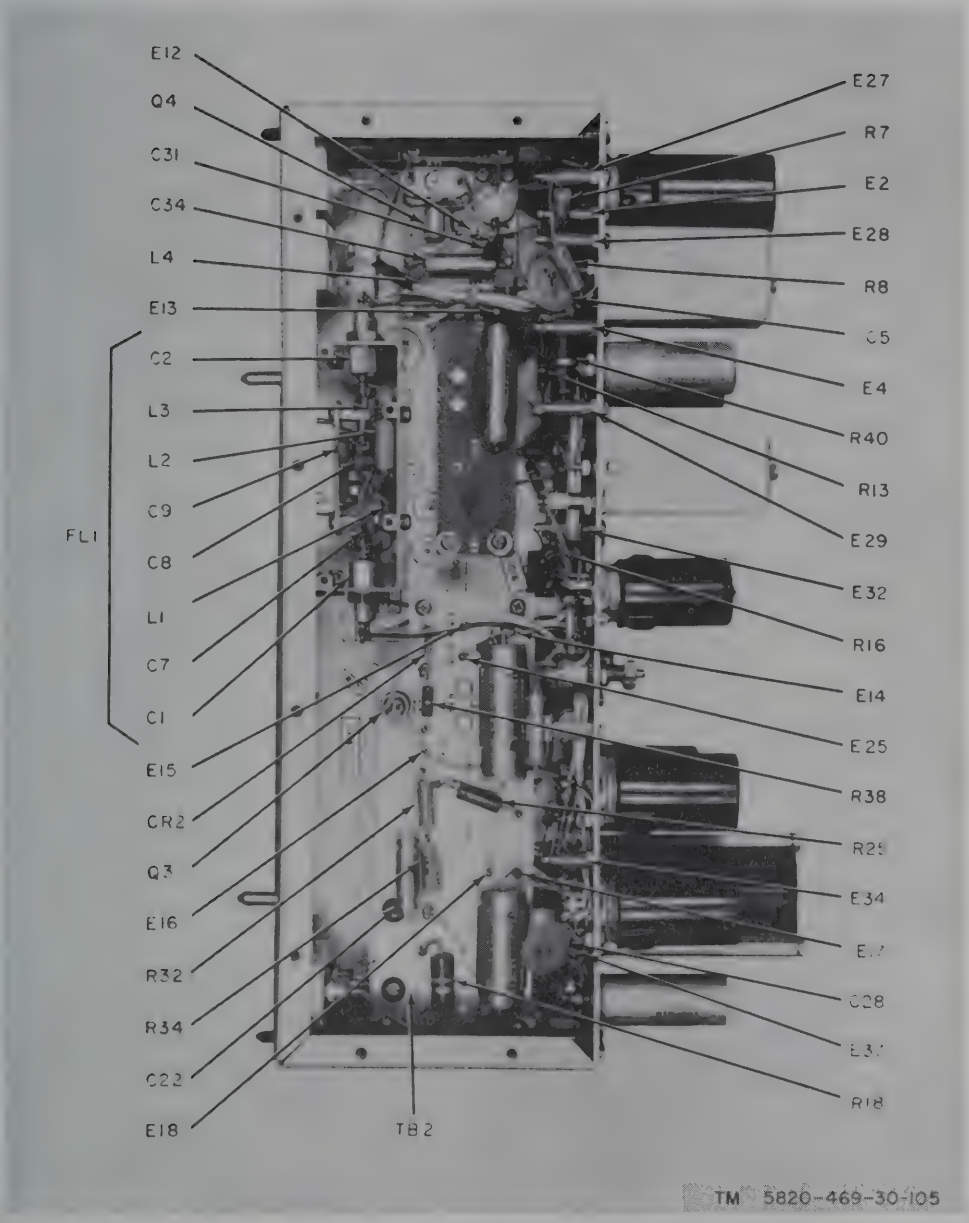


Figure 119. Chassis 2A5, discriminator-combiner, right side view.

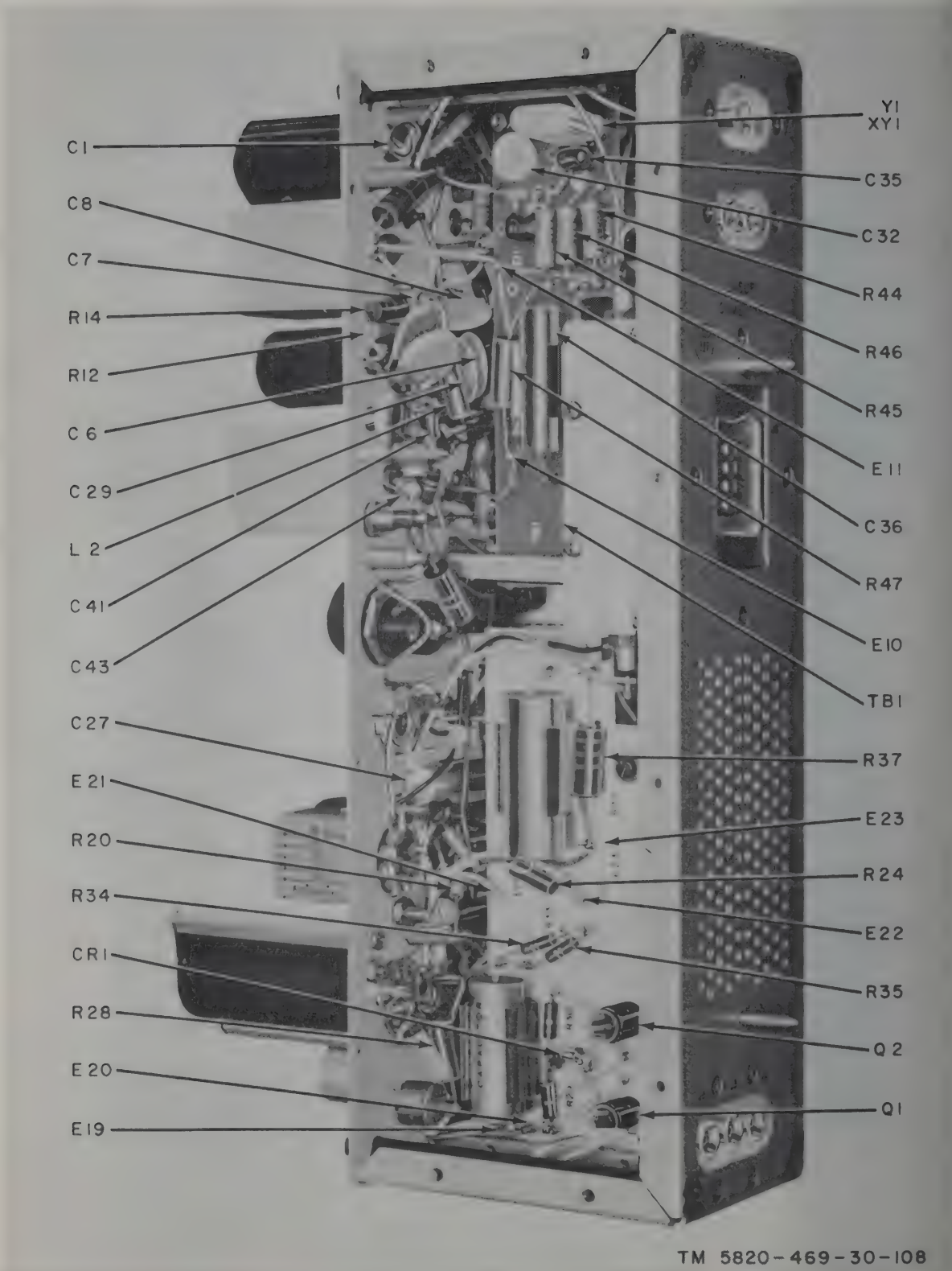


Figure 120. Chassis 2A5, discriminator-combiner, left oblique side view.

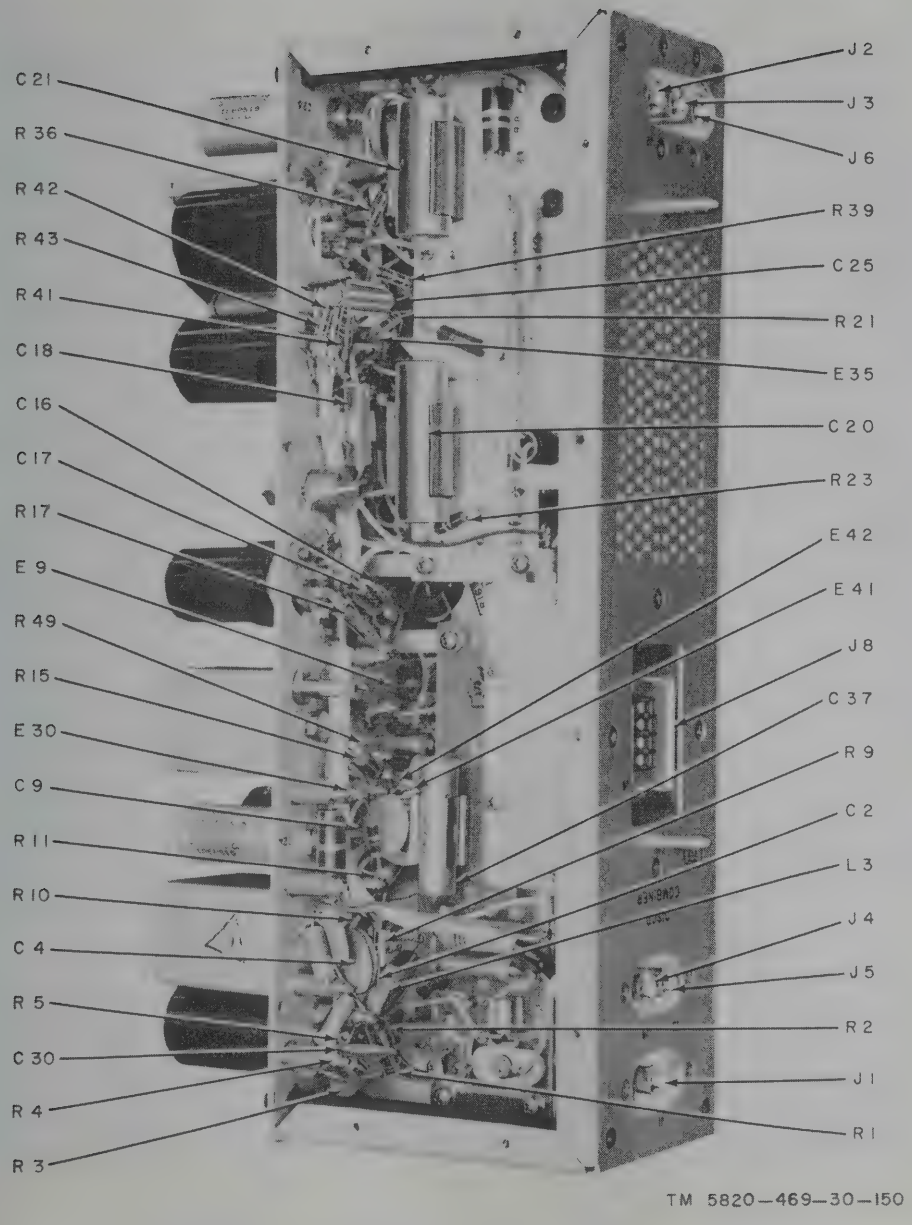


Figure 121. Chassis 2A5, discriminator-combiner, right oblique side view.

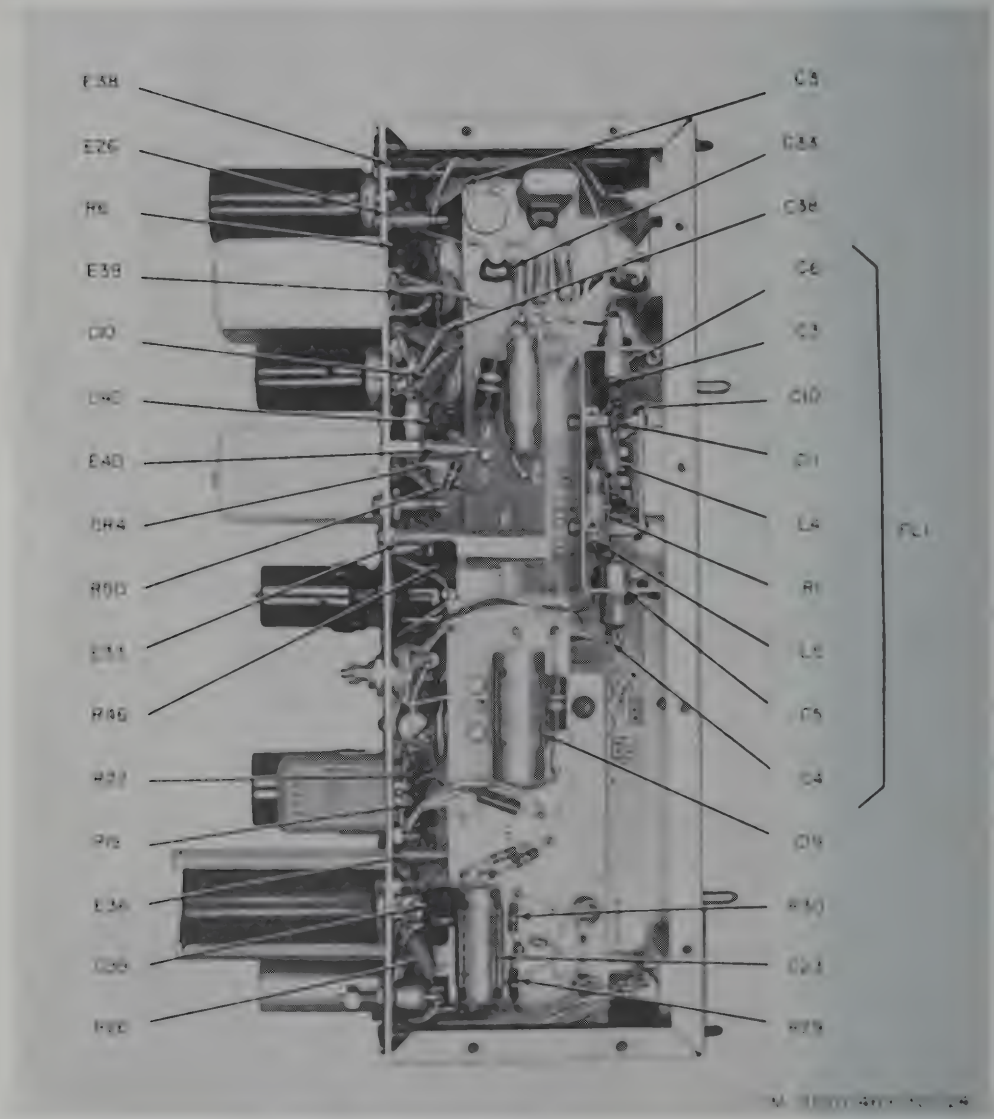


Figure 122. Chassis 2A5, discriminator-combiner, right side view.

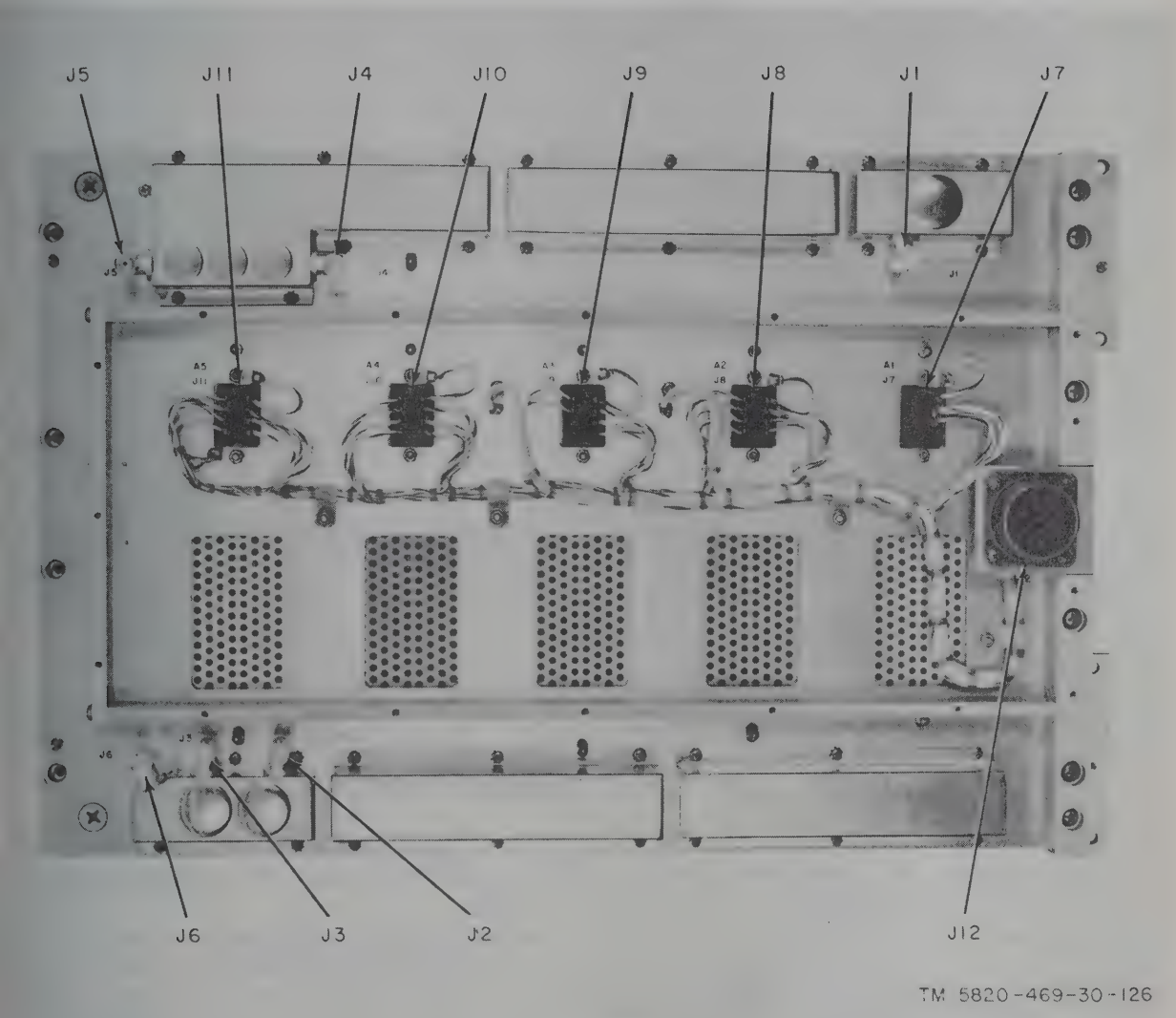


Figure 123. IF amplifier main frame, rear view, showing location of jacks.

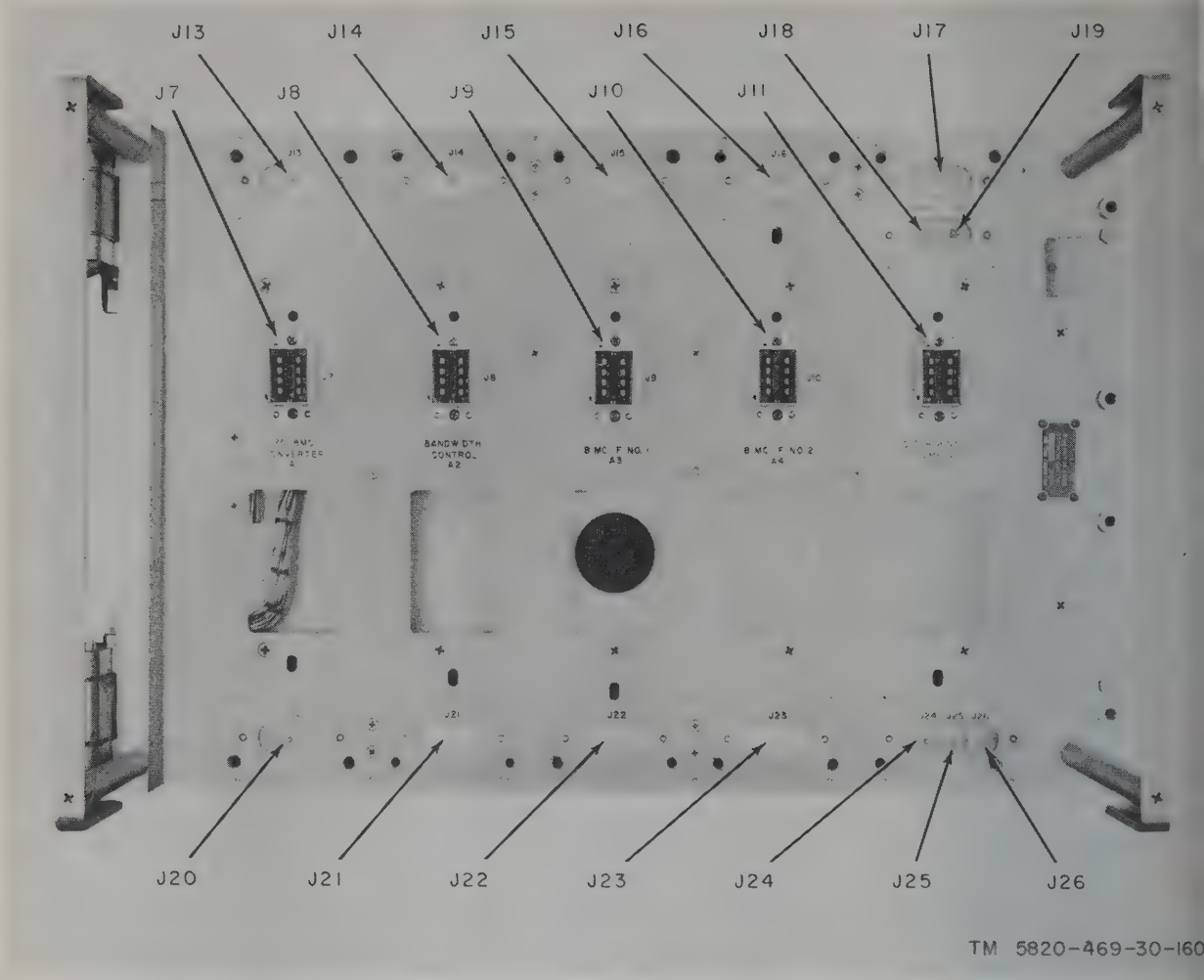


Figure 124. IF amplifier main frame, front view, showing location of jacks.

Section V. IF AMPLIFIER POWER SUPPLY TROUBLESHOOTING PROCEDURES

259. General

Loss of B+ in all subassemblies of the IF amplifier generally indicates that a common circuit in the power supply, such as time delay relay K1, line fuses, or power connectors may be defective. Refer to the complete schematic diagram (fig. 170) and the parts location illustrations (74, 126, and 127) to locate the defective component. Failure of the —6.3-volt dc source indicates a defect in bridge rectifier CR2 through CR5 or in the associated filter network. Failure of the 6.3 ac source (with all other outputs normal) indicates a defective transformer T1. Failure of one of the three B+ source voltages indicates that one of the thr self-contained power supplies (A1, A2, or A is defective. Since these power supplies a identical with the 200-volt power supply us in the transmit converter, refer to paragra 231 and adapt the troubleshooting procedur for all three power supplies.

260. IF Amplifier Power Supply Measurements

a. Test Connections. Refer to figure 125 a connect the IF amplifier power supply to t IF power supply (test set test facilities kit, f 150).

b. Measurements. All measurements listed below are from test points located *on the front panel of the power supply test set* (test facilities kit, fig. 150). All listed measurements are with respect to ground.

Circuit	Test point	ME–26/U (volts dc)	ME–30/U (millivolts ac)
ower supply module A1	200 VDC A1	190 to 210	2 to 10
ower supply module A2	200 VDC A2	190 to 210	2 to 10
ower supply module A3	200 VDC A3	180 to 200	2 to 10
ilament transformer T1	FILAMENTS 6.3 VAC		6.3 volts
c filament	FILAMENTS —6.3 VDC	—6.3 VDC ±0.4	2 to 10

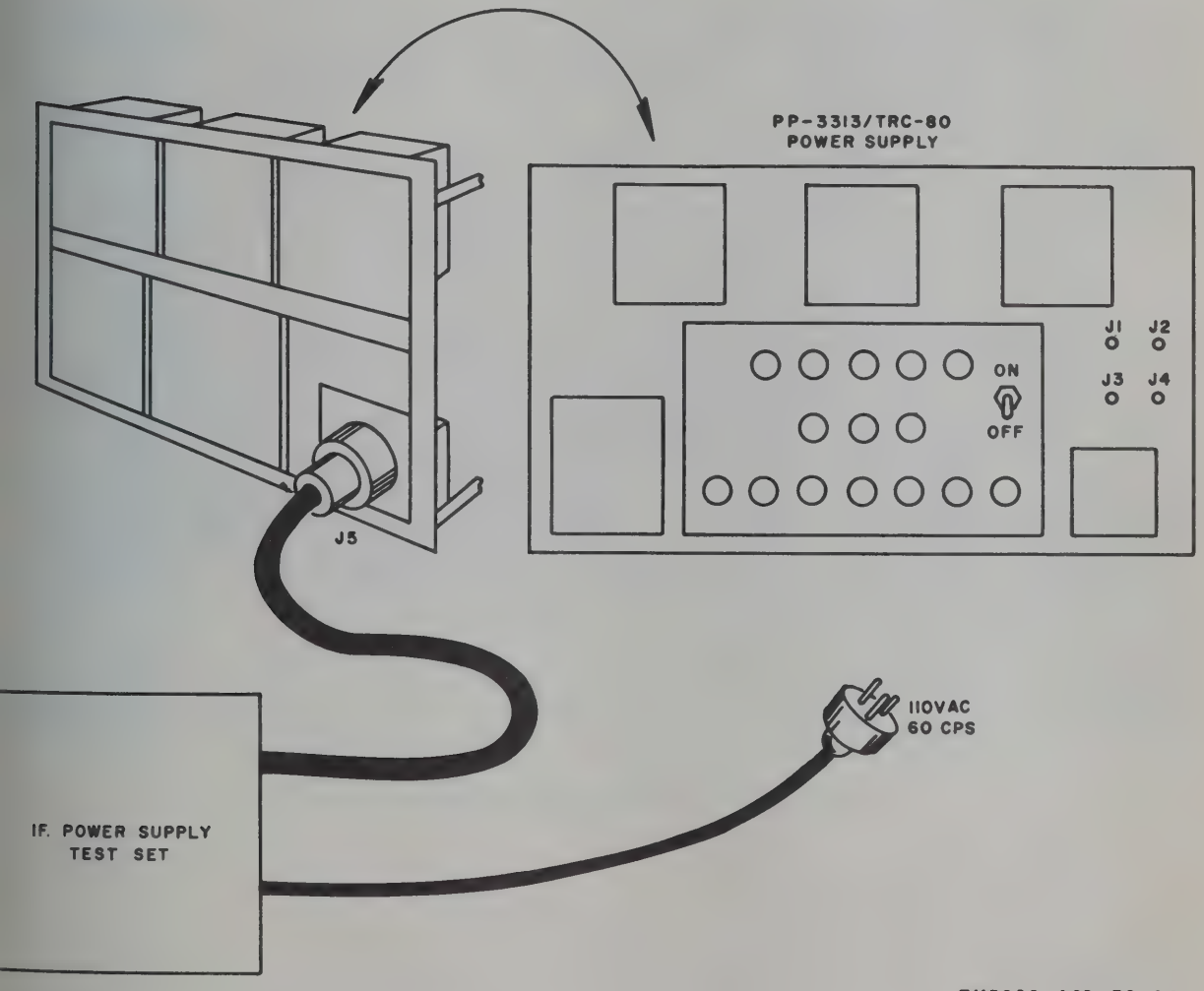


Figure 125. IF amplifier power supply, test setup.

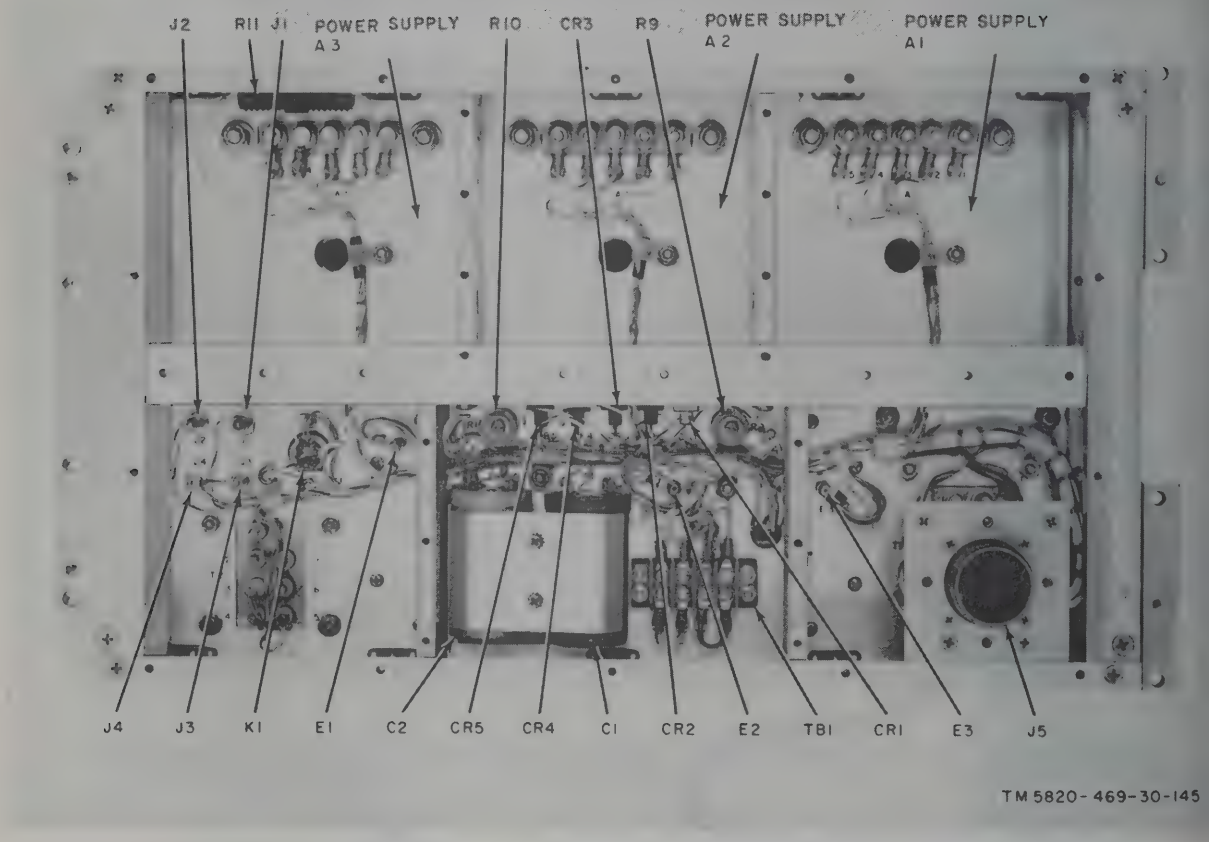


Figure 126. IF amplifier power supply, rear view.

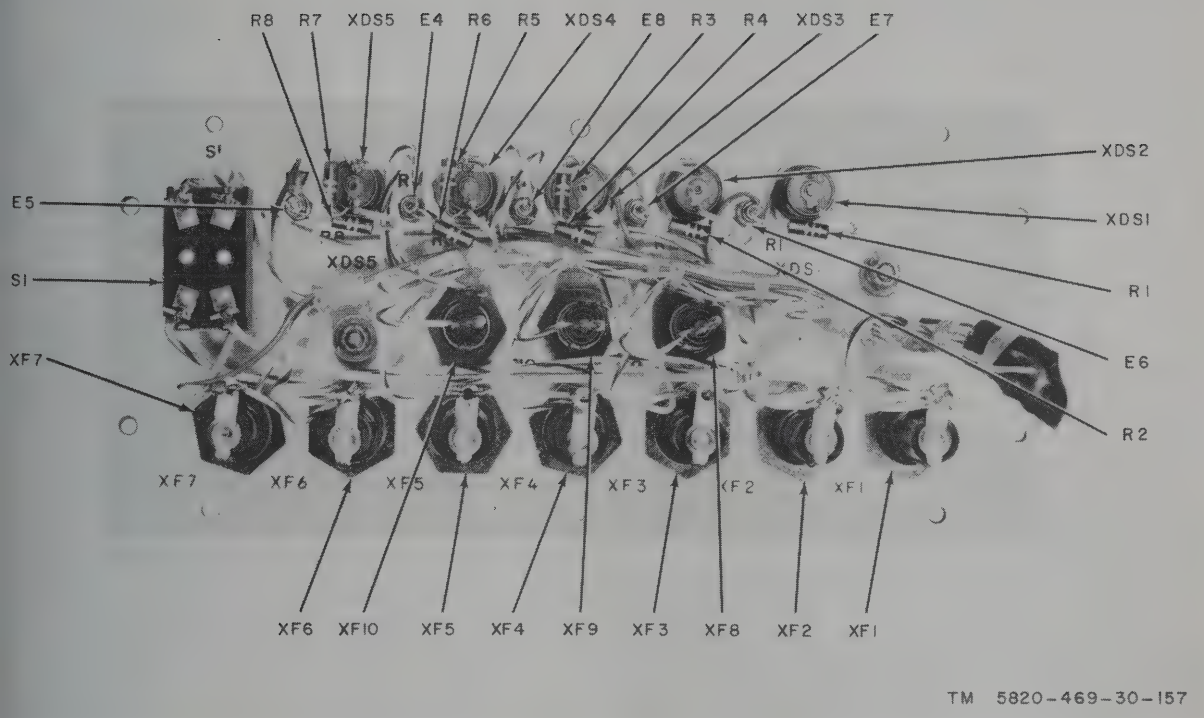


Figure 127. IF amplifier power supply, rear view of meter panel.

CHAPTER 19

CONTROL GROUP TROUBLESHOOTING

Section I. LOCALIZING TROUBLES

. General

he control equipment in the AN/TRC–80 sists of Electrical Frequency Synthesizer 37/TRC–80 (synthesizer), Demultiplexer-tiplexer TD–550/TRC–80 (multiplexer), io Frequency-Radio Frequency Monitor MX 9/TRC–80 (monitor), Power Distribution el SB–1565/TRC–80 (switch panel), Com-nication Control Panel SB–1564/TRC–80 ntrol panel), and a teletypewriter switch el. Detailed troubleshooting on the synthe-r and the control panel will *not* be per-ned by direct support maintenance person-However, since all the tty and voice cir-s are routed through the control panel, it is ntial that direct support maintenance per-nel are thoroughly familiar with the rout-of the voice and teletypewriter signals un-different operational modes through this rol panel. Prior to attempting to trouble-ot any of the circuits within the control up configuration, refer to paragraphs 160 161 and to the simplified functional dia-ms that support the text. Refer to the index ocate functional descriptions of the re-ning equipments within the control group.

262. Control Group Trouble Localization

When the trouble symptom is not known, refer to paragraphs 63, 64, and 65 of TM 11–5820–469–10 and attempt to tune the equipment. If a fault is observed during tuning, the trouble is generally located in the transmit or receive equipment groups. Refer to the appropriate chapters for troubleshooting data on these equipments. When tuning of the AN/TRC–80 does not indicate a fault, attempt to establish communication, using the teletypewriter and voice facilities (para. 71, TM 11–5820–469–10) of this equipment. When a defect is observed, refer to the voice and teletypewriter channels troubleshooting chart (para. 22, TM 11–5820–469–20) and to the communication facilities troubleshooting chart (para. 33, TM 11–5820–469–20). The localizing procedures in the organizational maintenance manual will normally localize defects to one of the major components of the control group, such as the multiplexer, synthesizer, etc. When the defective major component is localized, and the recommended procedures in the organizational maintenance manual do not restore normal operation, refer to the appropriate troubleshooting sections (paras. 263 through 276).

Section II. SYNTHESIZER

. Synthesizer Troubleshooting Procedures

The synthesizer consists of the frequency-erating components and power supply A601 128). The power supply is a self-contained which is identical with the 200-volt dc er supply used in the transmit converter er supply. If the FIL and PWR lamps do not light when the PWR switch is turned to ON, or if the synthesizer panel meter does not respond at any position of the meter switch, the defect is probably in power supply A601. Measure for 200 volts dc at J605 (fig. 128). If this voltage is low or missing, refer to paragraph 231 and adapt the transmit converter

200-volt power supply troubleshooting procedures for this power supply.

b. The frequency-generating components of the synthesizer (oscillator units 1, 2, and 3, and mixers 1 and 2) are not repaired at this level. If the measurements given in paragraph 264 indicate a defective synthesizer, replace the complete unit with a spare. Refer to paragraph 41 of TM 11–5820–469–20 for the removal procedures.

Note. As a field expedient, both receivers may be operated from one synthesizer. Use a BNC tee adapter (item 8, test facilities kit, fig. 150) at J604 (fig. 27, TM 11–5820–469–20) and connect both receiver cables to one synthesizer.

264. Synthesizer Voltage and Power Measurements

a. The voltage and power measurements in this paragraph will indicate if the synthesizer is functioning normally. To measure the output voltage at J604 (fig. 27, TM 11–5820–469–20), use a BNC tee adapter (item 8, test facilities kit, fig. 150) and the BNC resistive termi tion (item 2, test facilities kit, fig. 150) measure the loaded output voltage availa from the synthesizer. Connect the BNC adapter to J604 and the BNC resistive termi tion to one of the tee connectors. Posit meter selector switch S602 to MIXER 2 OU Using the ME–26B/U, measure the voltage the free end of the tee adapter. A typical re ing is 1.5 volts rms. (Approximately 1 volt r corresponds to the redline minimum of 30 the front panel meter (fig. 128). The minim usable synthesizer level is that voltage nec sary to permit a receive converter indicat of 50 (SET POINT on the H-XTAL CUR s ting). This may occur with as little as 0.5 v rms at J604 or an indication of 15 on the s thesizer front panel meter.

b. The power available at J604 may be me ured by the use of a 10-db attenuator (item test facilities kit, fig. 150) with the BNC adapter (item 8, test facilities kit, fig. 150) c nected to the AN/USM–96A. A typical pow measurement is 45 milliwatts.

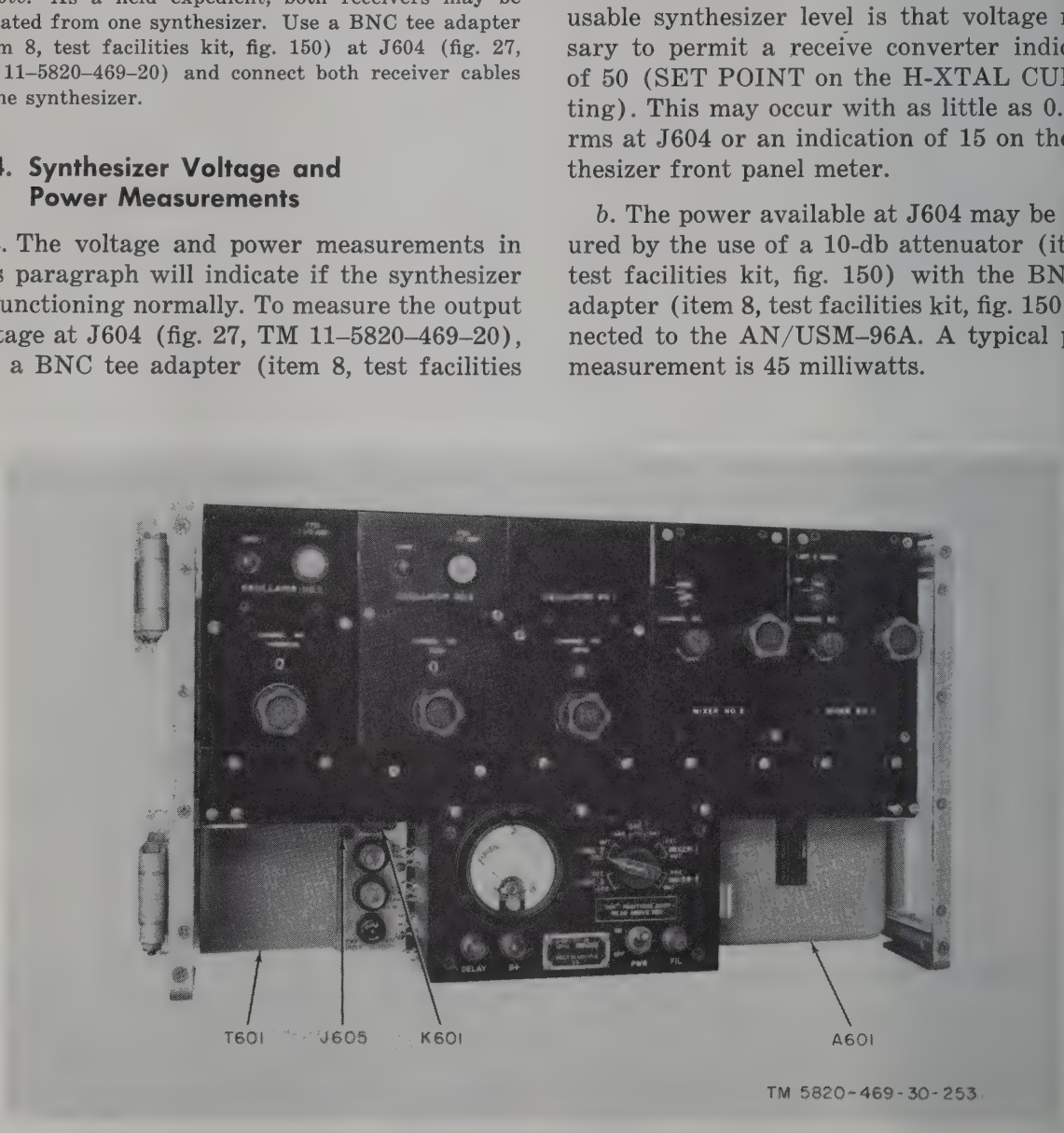


Figure 128. Synthesizer, front panel view, location of components.

Section III. MULTIPLEXER

65. Multiplexer and Communication Facilities Troubleshooting Procedures

Troubleshooting procedures at the organizational level (paras. 20 and 22, TM 11–5820–469–20) will generally localize troubles to defective tubes within the multiplexer or to equipment external to the multiplexer. The troubleshooting procedures in this section are divided to in-shelter checks and tests performed on the multiplexer unit when it is being serviced apart from the AN/TRC–80. The in-shelter checks will check the complete teletypewriter and voice systems in conjunction with the mux system, while the bench test is confined to locating defective components within the multiplexer unit. When the recommended procedures given in TM 11–5820–469–20 do not restore normal operation, perform the procedures given in paragraphs 266 and 267, in the order listed.

66. Multiplexer In-Shelter Tests

a. General. The functions of the multiplexer unit are discussed in paragraph 4. Refer to that paragraph to review the multiplexer functions that will be checked in this series of tests. The in-shelter checks include the use of all the equipment within the AN/TRC–80 that is used with the multiplexer during normal operation. If the desired indications are not obtained in the tests listed in *b* through *e* below, refer to *f* below for the test analysis.

b. Voice Transmit Test. Refer to paragraph 39*b*. Connect the equipment as specified and perform the procedures given in paragraph 39*b*(1) through (11). Retain the same connections (70-mc back-to-back rest) for the remaining in-shelter tests.

c. Radio Tty Transmit Test. Press TEST SIGNAL switch S1 on the control panel to remove the test tone, and proceed as follows:

(1) Press VF TTY pushbutton S18 (on the control panel) to select the COMMAND function, and place OPERATING MODE switch S2 (teletypewriter switch panel) in the NORMAL DC LOOP position.

Note. The VF TTY switch on the control panel connects TH–5A/TG voice-frequency tone lines to the radio circuits (J9, multiplexer chassis) when OPERATING MODE switch S2 is set to NORMAL DC LOOP.

(2) Press DC TTY pushbutton S17 to select PTS. Both selector switches on the TH–5A/TG should already be in their normal operating positions (NORM and 4W). Place PTS-BYPASS switch S1 on the teletypewriter switch panel to ON.

Note. In the PTS position of DC TTY switch S17, the TH–5A/TG dc send and received lines are connected direct to the teletypewriter. However, teletypewriter PTS terminals J31 and J32 (located on the switch panel) are placed in series with the receive line, permitting 20-ma dc transmission to the programmer test station if desired. Normally, PTS BYPASS switch S1 must be at ON to short these two terminals and complete the circuit to the local teletypewriter in order to test the machine for self-copy.

(3) Place selector switch S2 on the monitor to position F, LINE TTY IN. The monitor meter indication should equal or exceed the SET POINT if the TH–5A/TG is providing an adequate mark level at J9A and J9B on the multiplexer chassis. The SEND position on the TH–5A/TG selector switch can be used for this test also. This action overrides the carrier suppression circuit so that a mark tone will be transmitted continuously; otherwise, it is necessary to strike a keyboard character every 2 or 3 seconds to supply a teletypewriter test tone continuously.

d. Voice Receive Test.

(1) Place monitor switch S2 to E, LINE VOICE OUT and talk into the microphone.

Note. Because of the connections made in *b* above, this voice signal will be channeled through IF amplifier as a received signal.

(2) Adjust R42 on the multiplexer for a SET POINT indication on the monitor meter.

e. Radio TTY Receive Test.

(1) Place switch S2 on the monitor in position H, LINE TTY OUT and operate the local teletypewriter.

(2) Adjust radio tty output level adjust control R41 to obtain a SET POINT indication on the monitor meter.

f. Test Analysis.

(1) If it is difficult to complete any of the tests in *b* through *e* (above), the multiplexer may be defective. Refer to paragraph 267 for the troubleshooting procedures. In these tests, it is assumed that all other circuits and system wiring are functioning properly.

(2) When testing the radio tty receive function (*e* above) it is possible for the modulator-multiplier, the multiplexer, or the IF amplifier chassis to be defective (resulting in no G and H meter indications on the monitor) and still be able to type on the keyboard and receive a printed copy. This is a normal situation because a local-copy bridge circuit in the control panel is connected to the 0-dbm transmit tone line. When properly adjusted, this circuit returns, through relay connections, —25 dbm to the receive line. (The receive line sensitivity is normally adjusted to print with as little as —35 dbm at the input.) When running the 70-mc back-to-back teletypewriter system test (*b* above) with defective units, the priority amplifier in the control panel treats this condition as a no-received-signal condition and returns the self-copy circuit to operation. The TH–5A/TG, however, must be operating correctly if a teletypewriter self-copy test is to function.

Note. The TH–5A/TG itself has provisions for home copy (a strap is connected between D2 to F2), however, this internal strap from D2 to F2 is not used in the AN/TRC–80 and, if it is connected, it must be removed. This function is performed instead by the bridge circuit in the control panel as described above.

267. Multiplexer Bench-Testing Procedures

When the recommended procedures in t organizational maintenance manual (paras. and 22, TM 11–5820–469–20) do not resto normal operation, or if the in-shelter chec (para. 266) indicate that the multiplexer u is defective, remove the multiplexer from t shleter (para. 41, TM 11–5820–469–20) a set the unit on a service bench. Remove the p tective backplate and apply 115-volts, 60-c primary power at terminals 1 and 2 of T (fig. 130). When the power switch is turn on, the amber FILAMENT indicator shou light, and 30 seconds later the TIME DELA indicator should light. If these indications a not obtained, perform the checks listed in below. When performing the tests, in through *g* below, if the desired indications a not obtained, refer to the complete schema diagram (fig. 152), the parts locations ill trations (figs. 129–131), and the voltage a resistance diagram (fig. 188), and perfo voltage and resistance measurements on t suspected stages.

a. Power Supply Check.

(1) Using the ME–26B/U, measure t regulated dc voltage at the insulat standoff terminal adjacent to pin 1 tube socket XV6 or pin 1 of V10. T reading should be between 195 a 220 volts dc.

(2) Using the ME–30B/U, measure t power supply ripple at the same poi This reading should not exceed millivolts.

(3) Make voltage and resistance measu ments on V10, V11, and V12 a check the power input circuit fr TB2 through the fuses to transfor ers T9 and T10.

b. Clipping Level and Clipper Amplifier Te

(1) Connect SG–71/FCC (balanced o put) pins A and B of J10 (fig. 13 using the multiplexer test cable a termination adapter (item 31, test cilities kit, fig. 150).

(2) Using an ME–30B/U, adjust the put level to obtain 0 dbm at 2,000

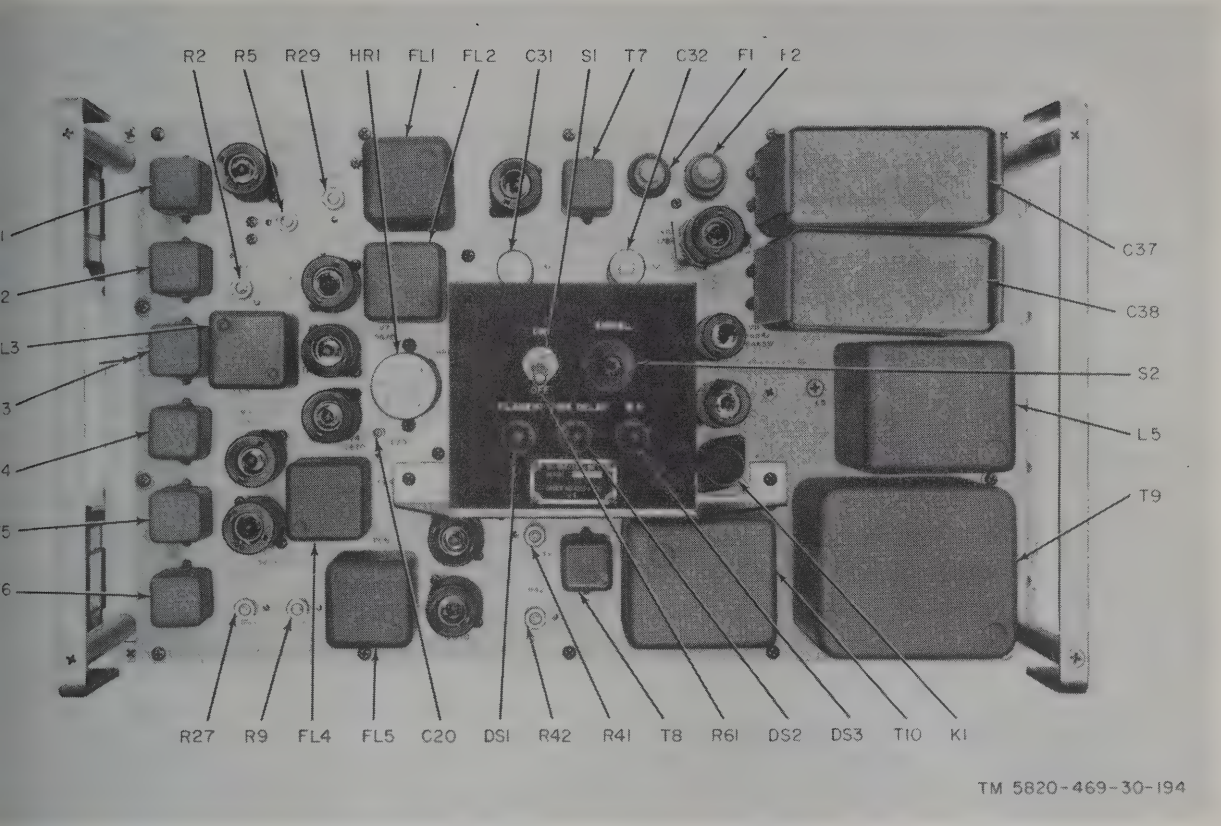


Figure 129. Multiplexer, front view, cover removed.

at monitor jack J1 (fig. 130) (This corresponds to +6 dbm across terminals A and B of J10.)

(3) Terminate output connector J5 with a resistive BNC termination (item 20, test facilities kit, fig. 150). With an ME–30B/U, measure and record the level at J6.

(4) Increase the input level (as measured at J1) to 10 db. Measure and record the level at J6.

(5) The difference in levels between those given in (3) and (4) above should not be more than 2.5 db. If the level difference exceeds 2.5 db, refer to paragraph 295 for the clipping level adjustment procedures. If no signal can be measured at J6, proceed to (6) below.

(6) Signal-trace through V1 and V6. Remember that filter FL1 (when tested by itself) passes signals only within the range of 100 to 3,500 cps. If the filter is removed and tested alone, insert a 5,000-ohm resistor in series with the signal generator and the filter input terminals. Measure the output voltage over the range specified or at some discrete frequency within the passband. The filter insertion loss should be not more than 5 db. When the defective stage is located, refer to figure 188 and perform the voltage and resistance measurements.

c. Voice Transmit Level Check.

(1) Connect the SG–71/FCC (balanced output) to pins A and B of J10, using the multiplexer test cable and termination adapter (item 31 test facilities kit, fig. 150). Adjust the SG–71/FCC for a 1,000-cps signal at —6 dbm (measured with an ME–30B/U) at input monitor jack J1.

(2) Terminate the output at J5, using a BNC tee adapter (item 8, test facilities kit, fig. 150) and the 287-ohm resistive termination (item 20, test facilities kit, fig. 150).

Note. The clipping level (*b* above) must be correct for this test to be conclusive.

(3) Measure the output level at J5 and adjust voice input level adjust control R29 to obtain an output level of —10 dbm as measured with the ME–30B/U.

(4) The response at 300 cps and 3,500 cps should not be down more than 3 db from the 1,000-cps reference.

(5) If signal values are low or missing, perform voltage and resistance measurements on V6.

d. Voice Receive Level Test.

(1) Connect the SG–71/FCC (unbalanced output) to J8. Adjust the SG–71/FCC for an output signal of 1,000 cps at —12 dbm as measured at J7 with an ME–30B/U.

(2) Terminate the output at pins D and E of J10; use the multiplexer test cable and termination adapter (item 31 test facilities kit fig. 150).

(3) Measure the level at output monitor jack J4 and adjust R42 to obtain an output of —6 dbm as measured with the ME–30B/U.

Note. The level measured at J4 will be 6 db lower than the level actually supplied to the communication control panel through terminals D and E of J10. This is normal because of the center tap on the audio output transformer T4 secondary winding.

(4) The response at 300 and 3,500 cps should not be down more than 3 db from the 1,000-cps reference.

(5) If either a low signal, or no signal can be measured at J4, perform the voltage and resistance measurements on V8B, filter FL5, and V5B, and their associated circuit components.

e. Radio Teletypewriter Transmit Level Check.

(1) Connect the SG–71/FCC to J9A a J9B, using the multiplexer test ca and termination adapter (item 31 t facility kit, fig. 150). Adjust the S 71/FCC for a 1,275-cps signal at - dbm as measured at J2 with the M 30B/U.

Note. It is necessary that the genera frequency be within the passband of vari filter circuits if proper measurements are be obtained. If in doubt, have the exact l band, mid-band, and high-band frequen (1,225, 1,275, and 1,325 cps) checked wit counter and marked on the generator dial a higher level maintenance facility bef performing this test.

(2) Terminate the output at J6, using 287-ohm resistive termination (it 20, test facility kit, fig. 150).

(3) Measure the output level of moni jack J5 with ME–30B/U and adj radio tty input level adjust control to obtain a level of —13.5 dbm.

(4) If difficulty is encountered, check 3-kc test oscillator (*g* below). It possible that the oscillator level is l or that the frequency is no lon within the specified limits. Narr bandpass filter FL2 will attenuate desired signals if the 3-kc oscilla is not properly adjusted.

Caution: **Do not adjust the osci tor frequency at this maintena level.**

(5) At input frequencies of 870 and 1,8 cps, the output level at monitor j J5 should be at least 20 db below midband level at J5. If it is not, ch filter FL2.

Note. When checking filter FL2, inse 5,000-ohm resistor in series with the inpu FL2 and the signal generator.

(6) In an emergency it is possible to t these circuits by use of the TH–5 TG as a signal generator. Connect output (4W-S, terminals 3 and 4) J9A and J9B. Select the SEND m to obtain a continuous mark tone. normal acceptable terminated out level measurement at J5 is —13.5 d ±3 db.

(7) If the desired output is not observed at J5, check mixer V2 and oscillator V7, and their associated circuit components.

f. Radio Tty Receive Level Test.

(1) Connect the SG–71/FCC (unbalanced output) to J8. Adjust the SG–71/FCC for a 4,275-cps signal at —15 dbm as measured at J7 with the ME–30B/U.

(2) Terminate the output at pins D and E of J9, using the multiplexer test cable and termination adapter (item 31, test facilities kit, fig. 150). Connect the ME–30B/U to monitor jack J3 and adjust radio tty output level adjust control R41 for a level of —15 dbm.

(3) The response at 3,800 and 4,800 cps should be at least 20 db below the midband reference output.

Note. If in doubt about the SG–71/FCC calibration accuracy, have the signal generator dial calibrated and marked for 4,225, 4,275, and 4,325 cps by a higher level maintenance facility.

(4) If either a low output or no output is available at J3, check T8, V8A, F14, V4, FL3, and V3A. Refer to the voltage and resistance diagram (fig. 188).

g. 3-Kc. Oscillator V7 Test.

(1) Three kc dual-crystal oscillator V7 can be checked by performing voltage and resistance measurements (fig. 188) for tube V7 and by using meter ME–30B/U to measure the audio level at cathode follower V3B. This level should be approximately 2.5 volts rms at pin 8 of V2. When SIGNAL test switch S2 is depressed, this audio tone will pass through V1 and V6. It should be audible when headphones are connected to J5 to J6.

(2) Trimmer capacitor C20 is provided to adjust the difference frequency to 3,000 cps ±20. *This adjustment requires a frequency counter not available for direct support maintenance. For this reason, C20 must not be adjusted in the field, nor should crystals Y1 and Y2 be replaced or interchanged in their sockets within oven assembly HR1.*

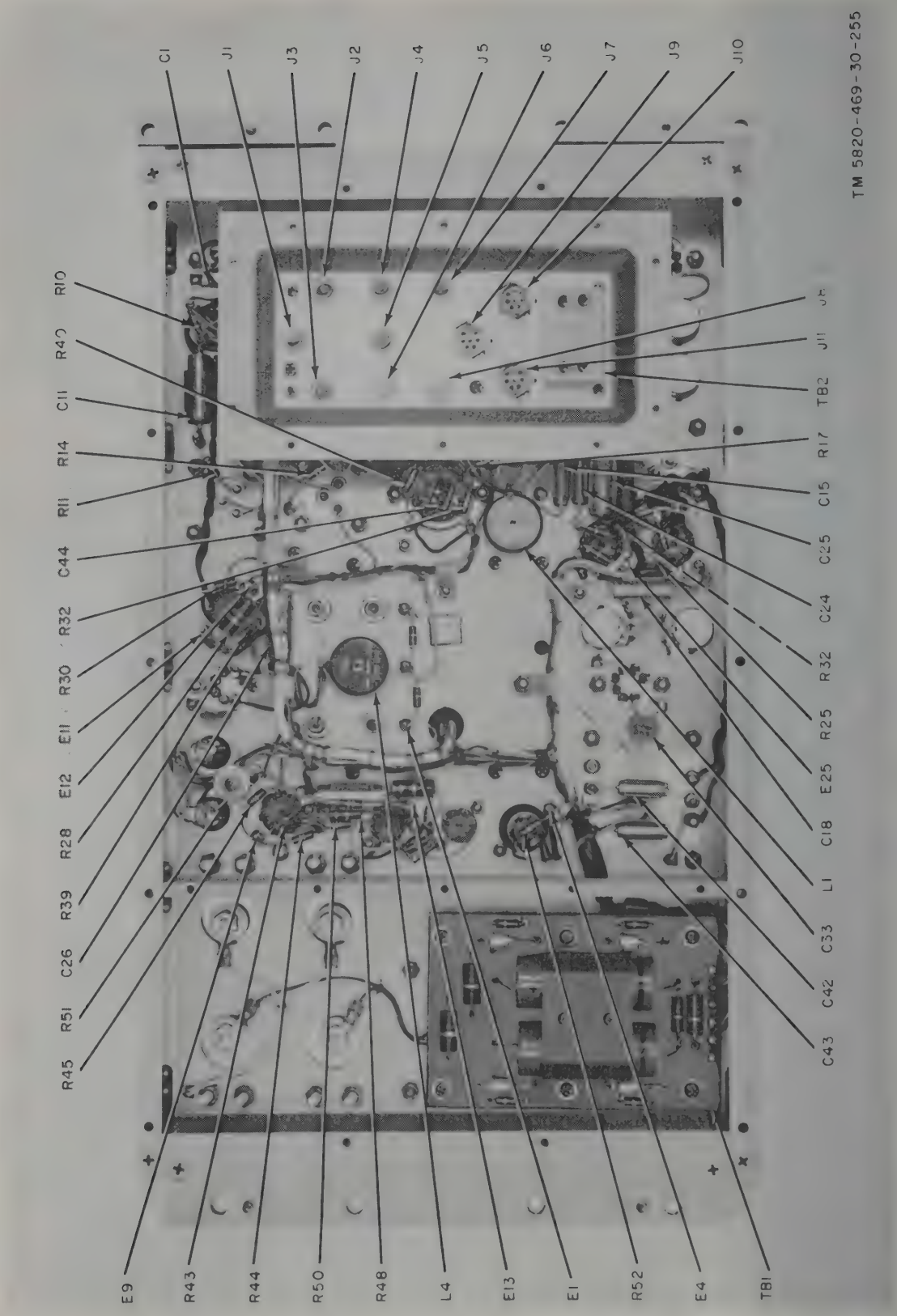


Figure 180. Multiplexer, rear view, cover removed.

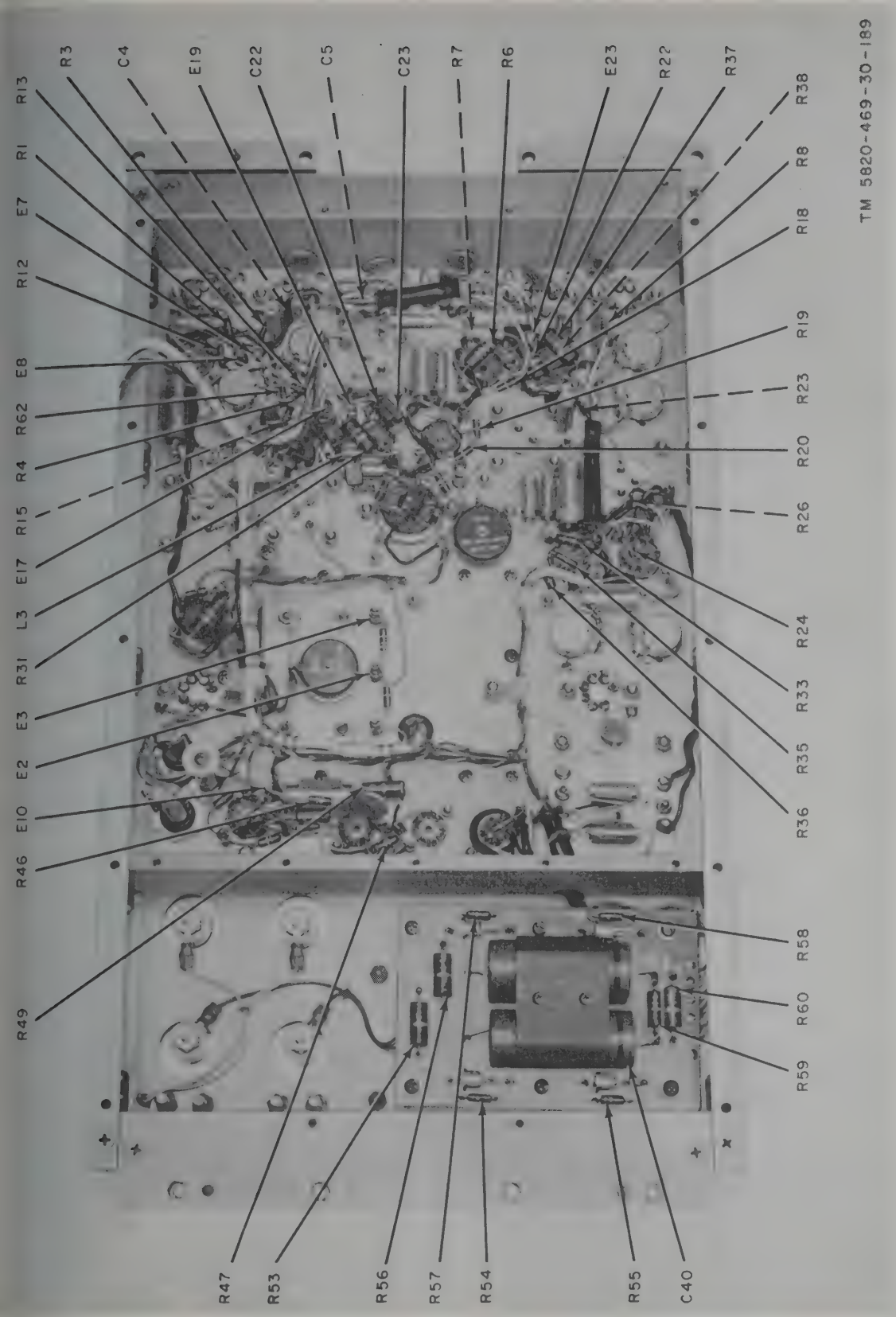
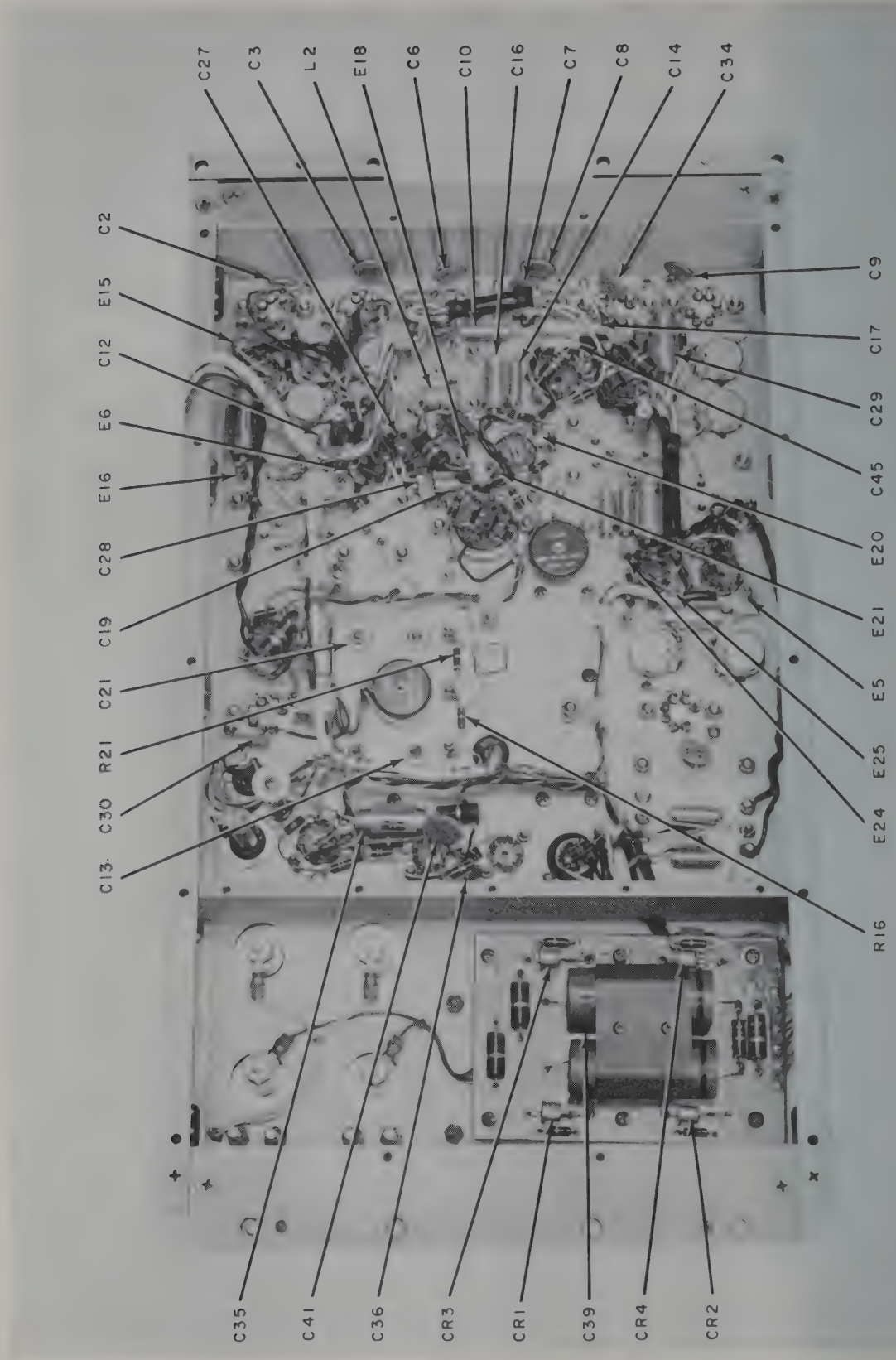


Figure 131. Multiplexer, rear view, terminal board TB2 removed (part 1 of 2).


C27
C3
L2
E18
C6
C10
C16
C7
C8
C14
C34
C2
E15
C12
E6
E16
C28
C19
C21
R21
C30
C13
C9
C17
C29
C45
E20
E21
E5
E25
E24
R16
C35
C41
C36
CR3
CR1
C39
CR4
CR2
TM5820-469-30-190

Section IV. MONITOR

8. General

a. Troubleshooting procedures for the monitor at the organizational level (para. 25, TM 5820–469–20) will generally localize troubles to defective tubes or connectors. Because of the measurement function that this chassis performs, it is almost impossible to judge its accuracy or acceptable performance while it is mounted on the rack. If tests on other parts of the AN/TRC–80 suggest a faulty monitor rather than faulty system components, it will be necessary to remove the monitor and replace it with a spare. If all meter indications are then normal, the unit just removed is obviously defective. Refer to paragraph 269 for the monitor troubleshooting procedures.

b. If all the monitor meter indications are inaccurate, or random readings are observed when the equipment appears to be operating normally, it is possible that deviation set point adjust potentiometer R71 or test tone voltage level set point adjust potentiometer R70 (fig. 135) may be misadjusted. Refer to paragraph 297 for the adjustment procedures.

Caution: **Resistors R70 and R71 must be adjusted (para. 297) whenever any extensive repairs have been performed on the monitor chassis.**

9. Monitor Troubleshooting Procedures

a. *General.* Paragraphs 197 through 204 discuss the various functions of the monitor. Review these paragraphs before attempting to repair or adjust any portion of the monitor. Note that there are five functional areas—70-mc RF amplifiers V1 through V4; the discriminator circuit, consisting of V5A, CR1, and CR2; the audio amplifier section, consisting of V5B and V6; the power supply; and the meter-driver circuit. The procedures for troubleshooting these five sections are contained in *b* through *e* below. Use the complete schematic diagram (fig. 185) for circuit tracing. Refer to figure 132 for voltage and resistance measurement data, and to figures 133 through 138 for the parts locations.

b. Test Connections. Connect Signal Generator AN/URM–48 to jack J8 (fig. 22, TM 11–5820–469–20); use a BNC adapter (item 11, test facilities kit, fig. 150). Set the generator to 70 mc and adjust the RF input level for approximately 0.2 volt. Frequency-modulate the 70-mc signal with a 1,000-cps signal to produce a 9-kc peak deviation; use the self-contained meter on the signal generator to check the desired deviation. Apply 60-cps primary power at terminals 1 and 2 of TB1 (fig. 22, TM 11–5820–469–20).

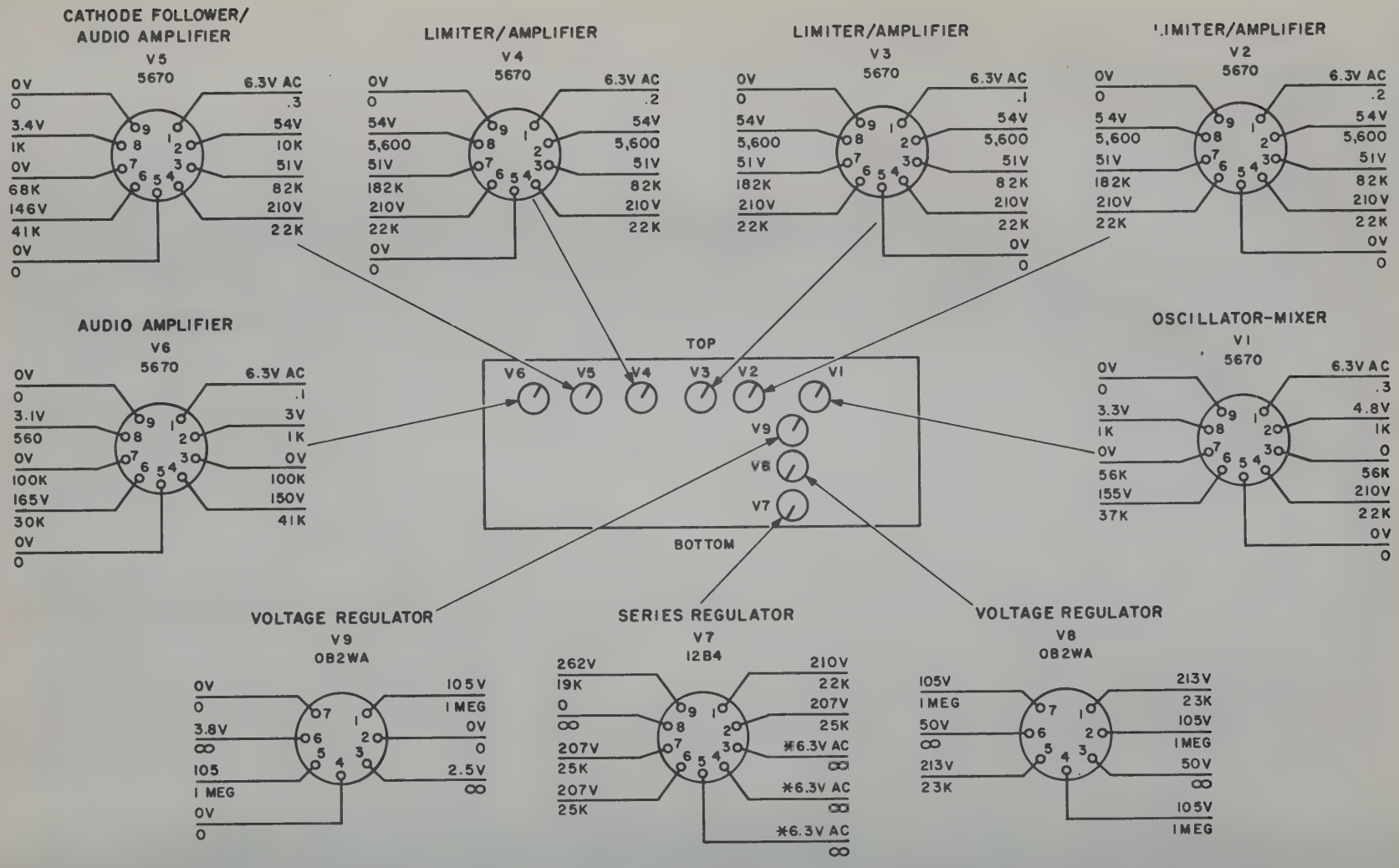
c. Power Supply. Measure the B+ voltage at pin 1 of V7 (fig. 132). The ME–26B/U should indicate between 197 and 216 volts dc. Measure the ripple voltage at this point with an ME–30B/U. The ripple voltage should not exceed 250 millivolts. If the dc voltage is low or missing, refer to the voltage and resistance diagram (fig. 132) and check the voltage levels from the ac input at TB1 through, to the dc output at pin 1 of V7. If the ripple voltage is high, check capacitors C39 and C40 (fig. 137).

d. RF, AF, and Discriminator Sections.

(1) With the AN/URM–48 connected as directed in *b* above, set the two front panel switches, S1 and S2, to positions A.

(2) The monitor is now functioning as an fm deviation meter. If a SET POINT indication is obtained on the front panel monitor meter, the RF stages, discriminator, and audio stages, and the meter are functioning normally. If the desired indication is not obtained, perform voltage and resistance measurements on the RF and AF stages. Start with audio amplifier V6B and work back toward input jack J8.

e. Meter Circuit. If a satisfactory meter indication is obtained in *d* above, the meter is functioning normally. To check the meter attenuation and shunting networks, refer to the schematic diagram (fig. 185) and the parts location illustrations. Check for continuity from the various input jacks (J1 through J7, and J9) to the corresponding pins on switch S2A.



NOTES:

1. VOLTAGES MEASURED TO GROUND WITH A VACUUM TUBE VOLTMETER (ME 26/U)
2. VOLTAGE READINGS WERE MADE WITH 120V AC PRIMARY POWER APPLIED TO TB1 WITH SWITCHES S1 AND S2 IN POSITION A
3. FOR RESISTANCE MEASUREMENTS ONLY, DISCONNECT ALL EXTERNAL PLUGS
4. VOLTAGE READINGS ARE ABOVE THE LINES AND, RESISTANCE READINGS ARE BELOW THE LINES

* ON TUBE V7, PINS 4 AND 5 ARE CONNECTED TOGETHER AND FILAMENT VOLTAGE SHOULD BE MEASURED BETWEEN PIN 3 AND PIN 4/5 WITH A MULTIMETER

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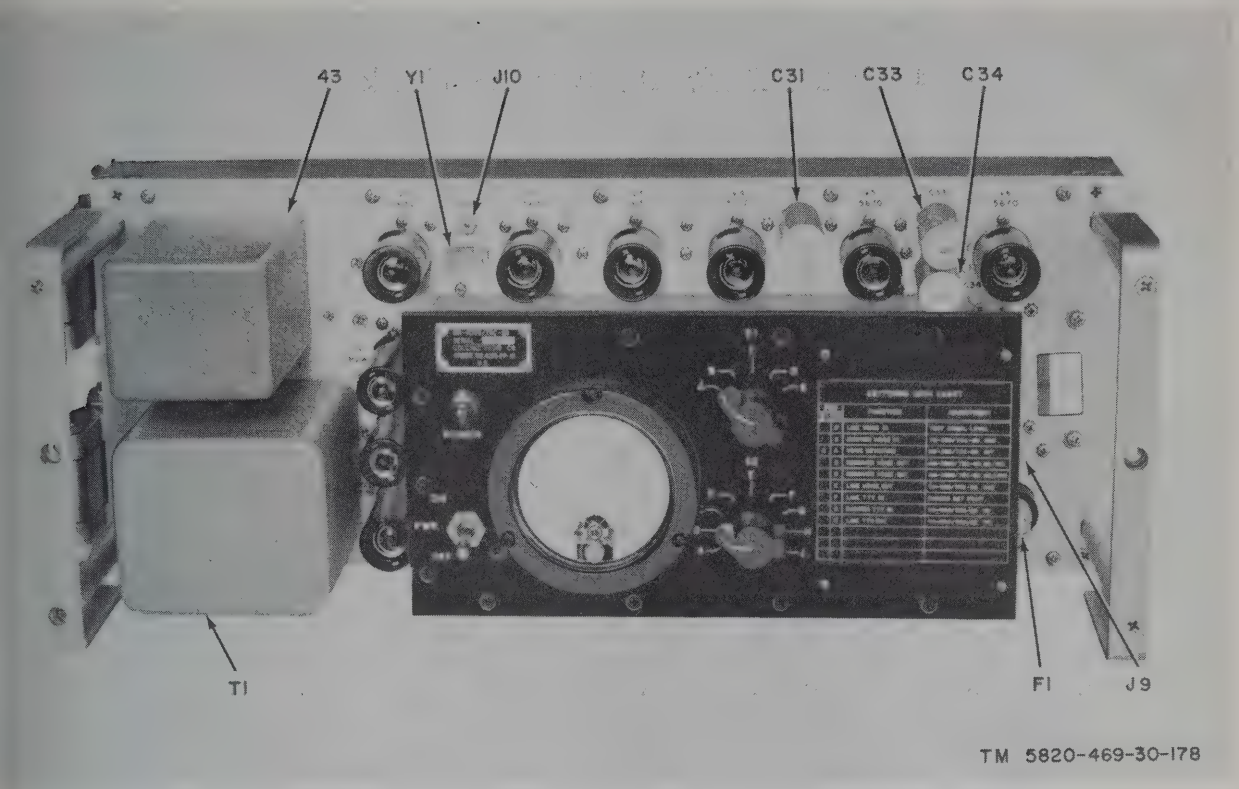


Figure 133. Monitor, front view, cover removed.

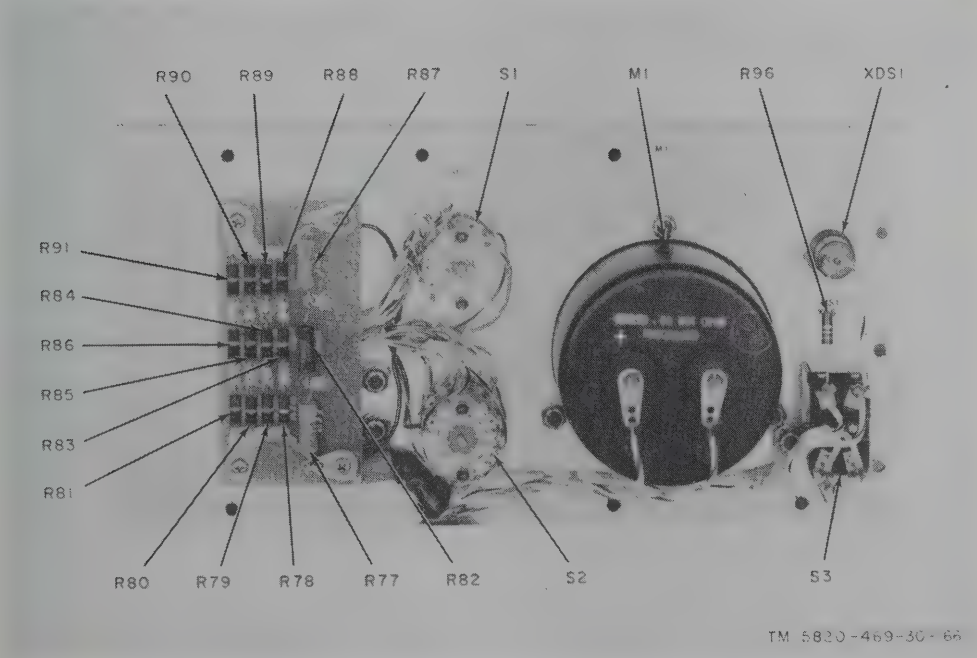


Figure 134. Monitor, rear view of meter panel.

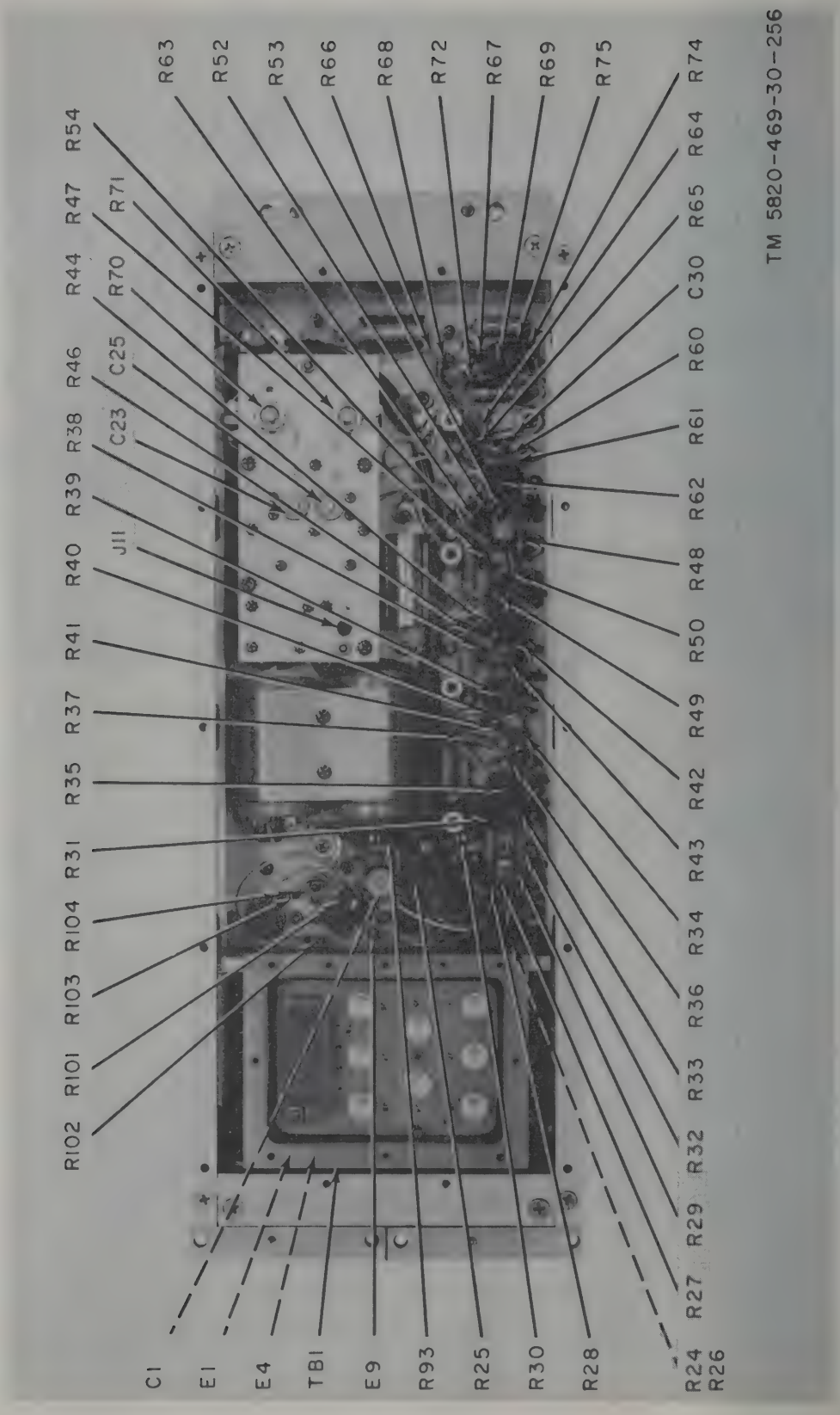


Figure 185. Monitor, rear view, cover removed.

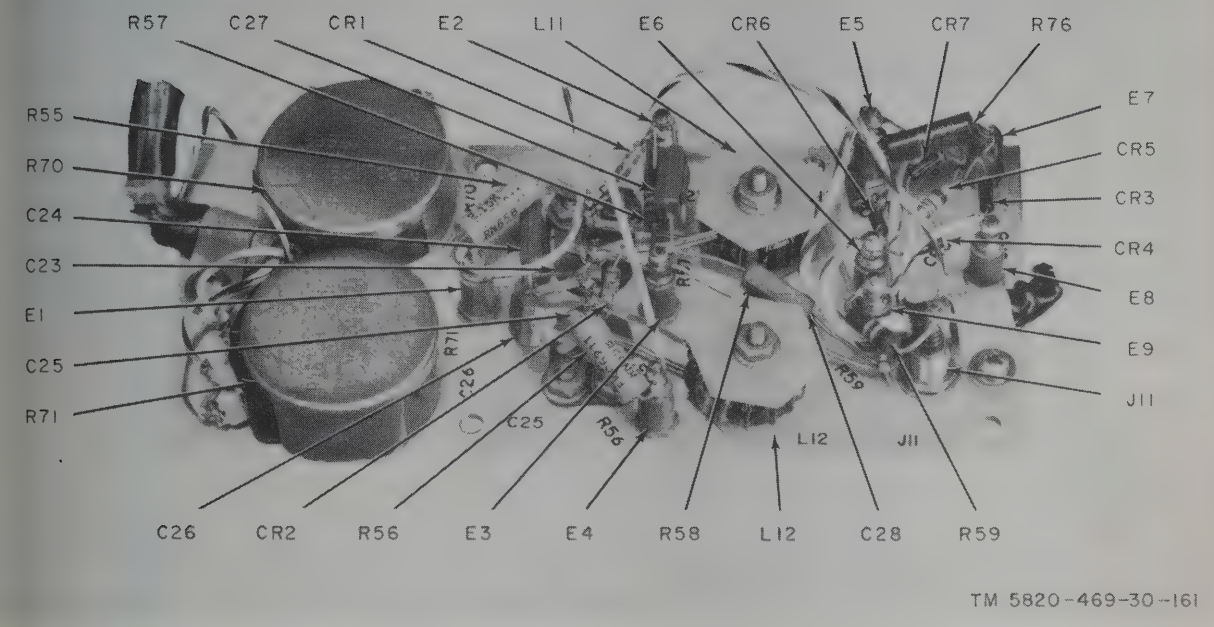


Figure 136. Monitor, bottom view of control panel.

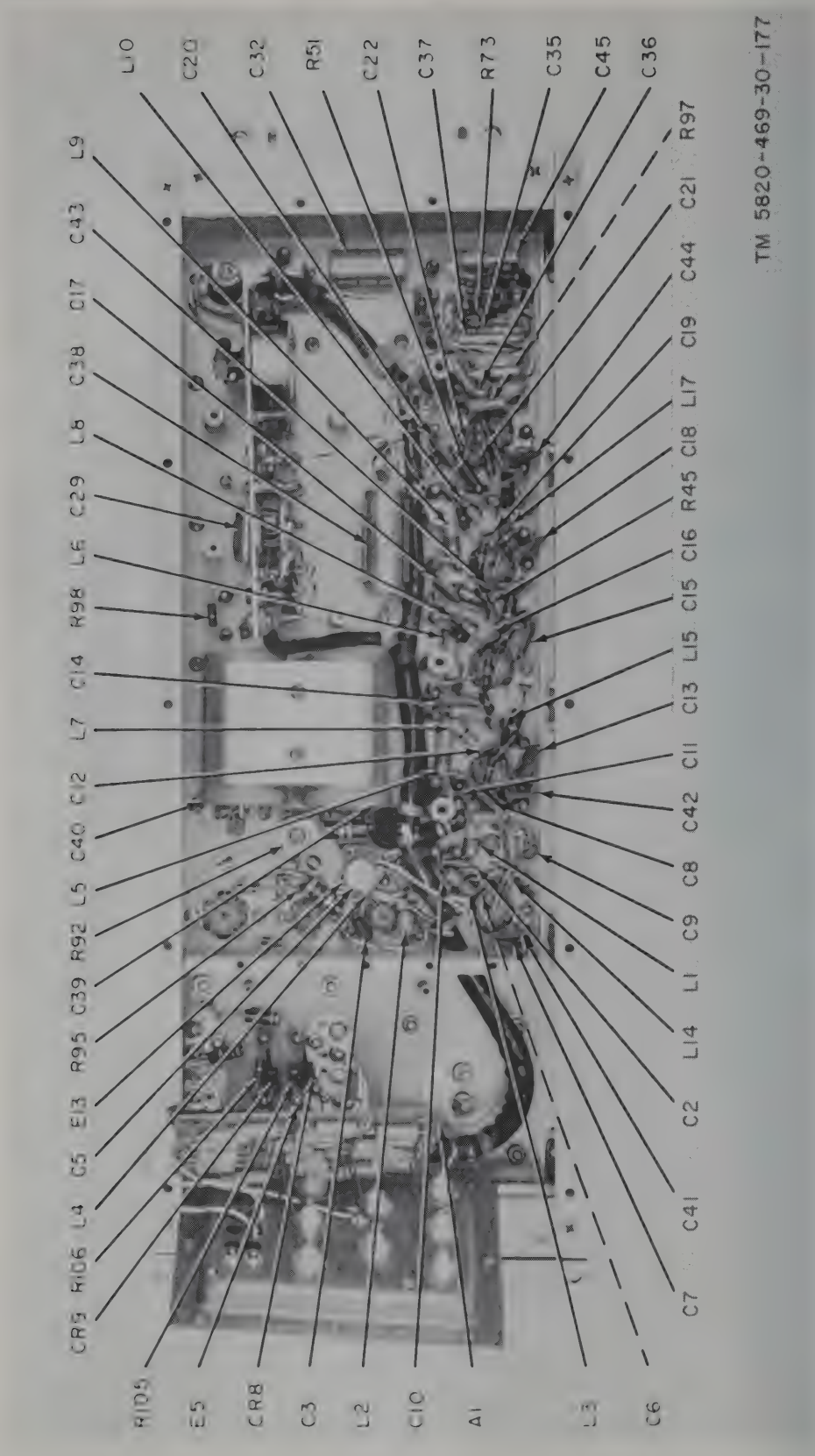


Figure 137. Monitor, control panel removed, rear view (part 1 of 2).

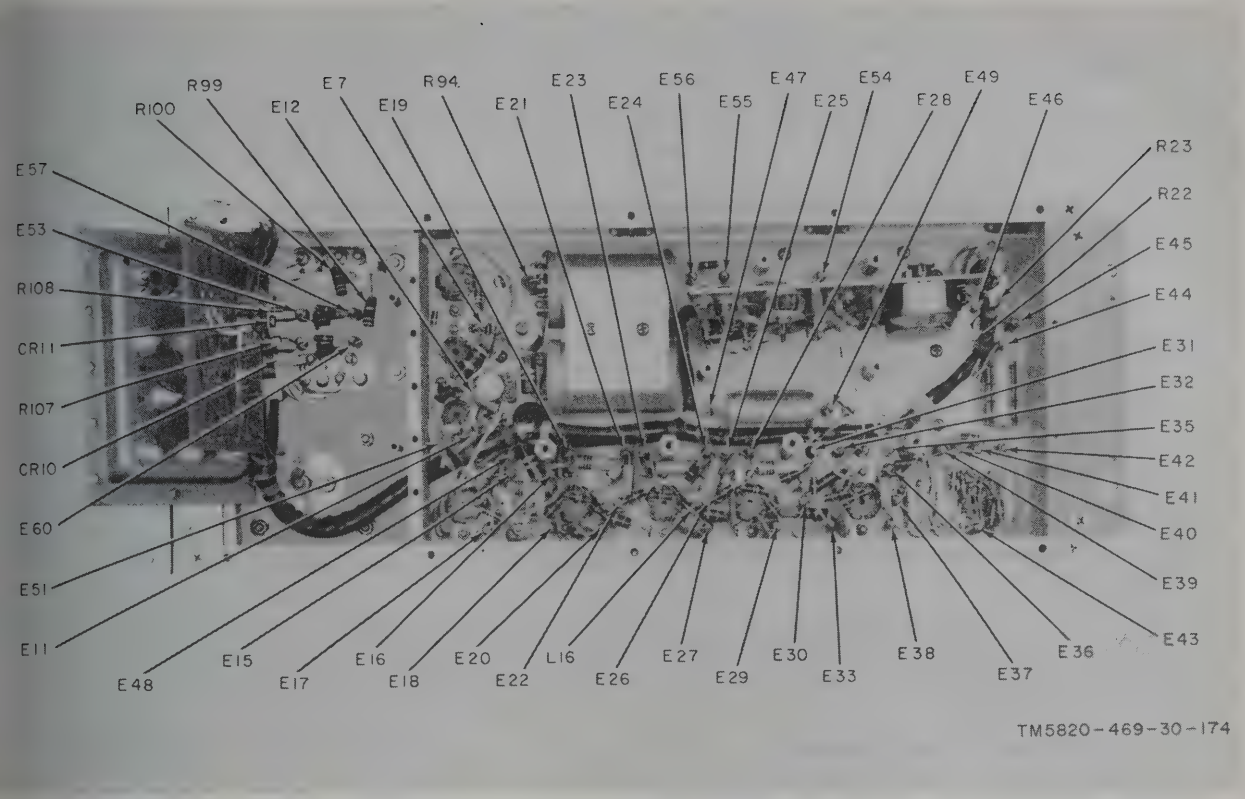


Figure 137. Monitor, control panel removed, rear view (part 2 of 2).

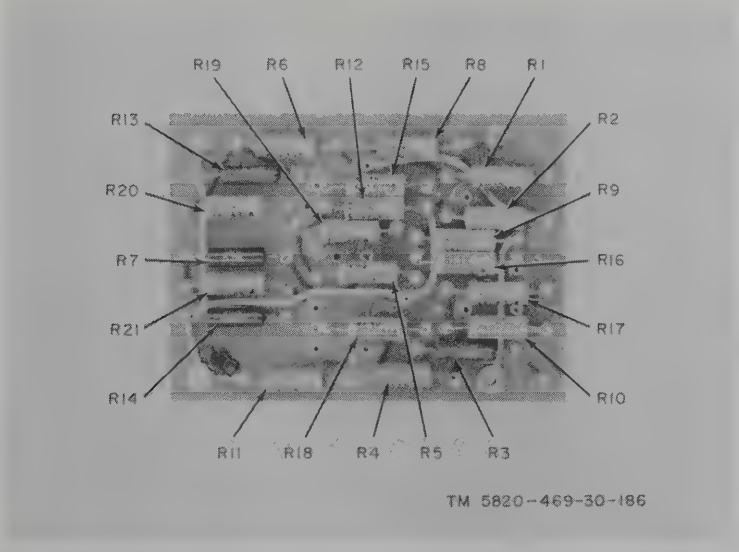


Figure 138. Monitor, component board A1, location of components.

Section V. SWITCH PANEL

270. General

The switch panel consists primarily of switches, connectors, indicators, and fuses and contains no active components. Troubles in the switch panel will generally be confined to input or output connectors or dirty or broken contacts on switches S1 and S2. When trouble has been localized (para. 24, TM 11–5820–469–20) to the switch panel, refer to paragraph 41 of TM 11–5820–469–20 and remove the switch panel. Replace the panel with a known good unit. If the good unit clears the trouble, set the defective switch panel on a service bench and perform the checks listed in paragraph 271 to locate the defect. Use the schematic diagram (fig. 183) and the parts location illustrations (figs. 139 and 140) for component identification. Refer to figure 26 in TM 11–5820–469–20 for the locations of the rear panel jacks.

271. Switch Panel Measurements

Perform the following series of continuity measurements to localize the trouble. Refer to the schematic diagram of the switch panel (fig. 183).

a. DEMULT-MULT-MOD SELECTOR Switch S1.

(1) LOCAL position:

J6 to J7	Continuity
J6 to ground	619 ohms

(2) PARALLEL position:

J6 to J7	Continuity
J6 to J14B	Continuity
J6 to ground	Infinity

(3) REMOTE position:

J7 to J14B	Continuity
J7 to ground	Infinity

b. LOCAL-REMOTE COM CONTROL Selector Switch S2.

(1) CONTROL position:

J14	pins M to X	Continuity
	pins S to V	Continuity
	pins L to Y	Continuity
	pins R to W	Continuity
	pins D to b	Continuity
	pins C to c	Continuity
	pins G to a	Continuity
	pins H to Z	Continuity

(2) TIE position:

J14	pins P to X	Continuity
	pins U to V	Continuity
	pins N to Y	Continuity
	pins F to b	Continuity
	pins E to c	Continuity
	pins K to Z	Continuity
	pins a to J	Continuity
	pins R to S	Continuity

(3) SLAVE position:

J14	pins M to P	Continuity
	pins S to U	Continuity
	pins R to T	Continuity
	pins L to N	Continuity
	pins D to F	Continuity
	pins H to K	Continuity
	pins C to E	Continuity
	pins G to J	Continuity

c. Miscellaneous Continuity Tests. Set the following switches to the OFF positions.

(1) RACK POWER, RACK BLOWERS, HUT LIGHTS, FLUSHING BLOWER:

J13	pin N to P	Infinite
	pins N to S	Infinite
	pins N to R	Infinite
	pins A to B	Continuity

(2) Set the RACK POWER switch to the ON position.

J13	pin T to P	Continuity
	pins U to R	Continuity
	pins U to D	Continuity
	pins R to W	Continuity
	pins E to S	Continuity
	pins E to V	Continuity
	pins S to X	Continuity

(3) Set the RACK POWER switch to the OFF position and the HUT LIGHTS switch to the ON position.

J13	pin L to P	Continuity

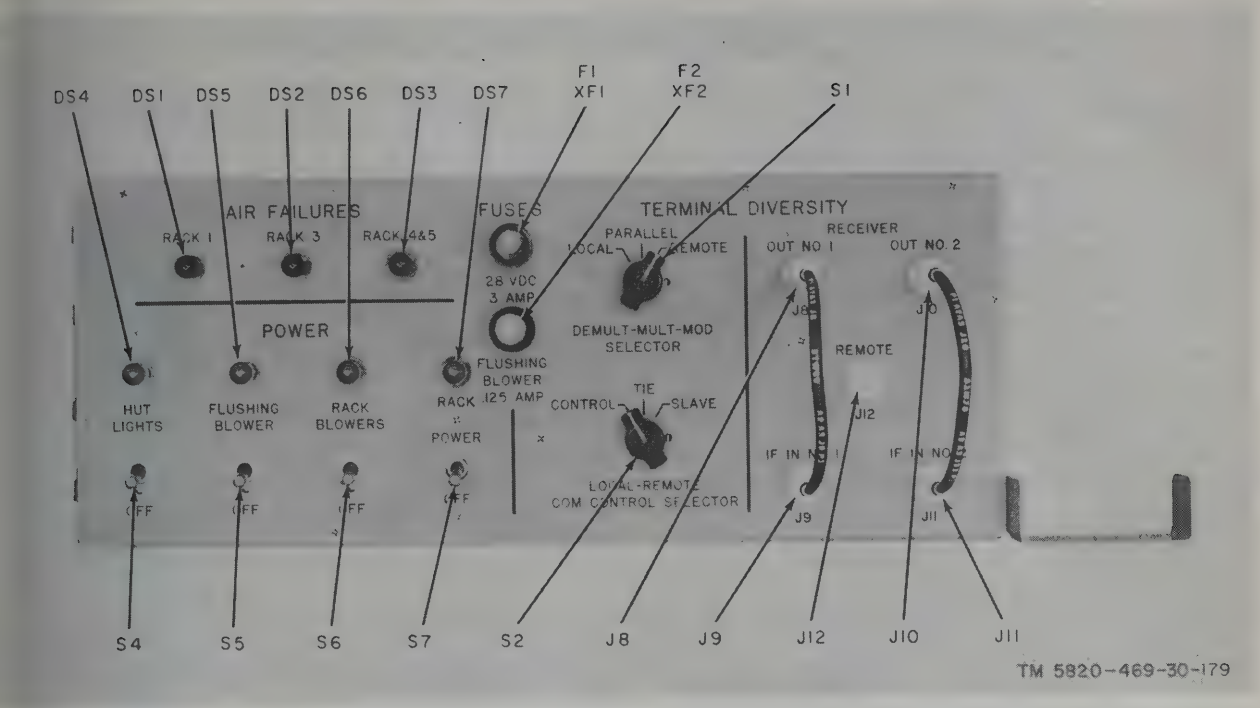


Figure 139. Switch panel, front panel view.

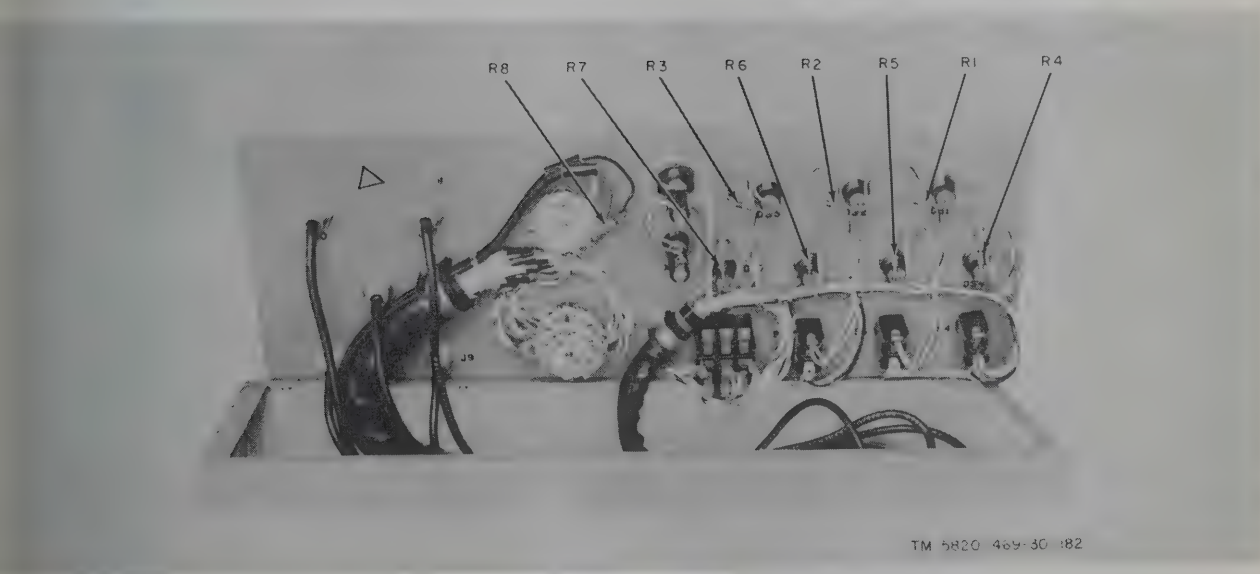


Figure 140. Switch panel, rear view.

Section VI. CONTROL PANEL, TELETYPEWRITER SWITCH PANEL, POWER AND SIGNAL ENTRY PANEL, CIRCUIT BREAKER PANEL, AND BLOWER

272. General

When trouble is localized to a defect external to the radio transmission and receiving equipments, the trouble generally lies within one of the panels that control the communication facilities of the AN/TRC–80. When trouble within one of these panels is suspected, perform the following:

a. Refer to paragraph 33 of TM 11–5820–469–20 to localize the trouble to one of the panels that control signal routing and operational modes.

b. If difficulty in voice lines is experienced, refer to paragraph 160 and review the voice and test signal functions of the control panel.

c. If difficulty with teletypewriter lines is encountered, be sure that the two switches on the switch panel (fig. 139) and the three switches on the teletypewriter switch panel are set correctly for the desired mode of operation (para. 71, TM 11–5820–469–10). Figures 13, 14, and 15 are simplified functional diagrams showing circuit routing under various teletypewriter operational modes. Refer to paragraph 161 and review the tty signal routing for differ-

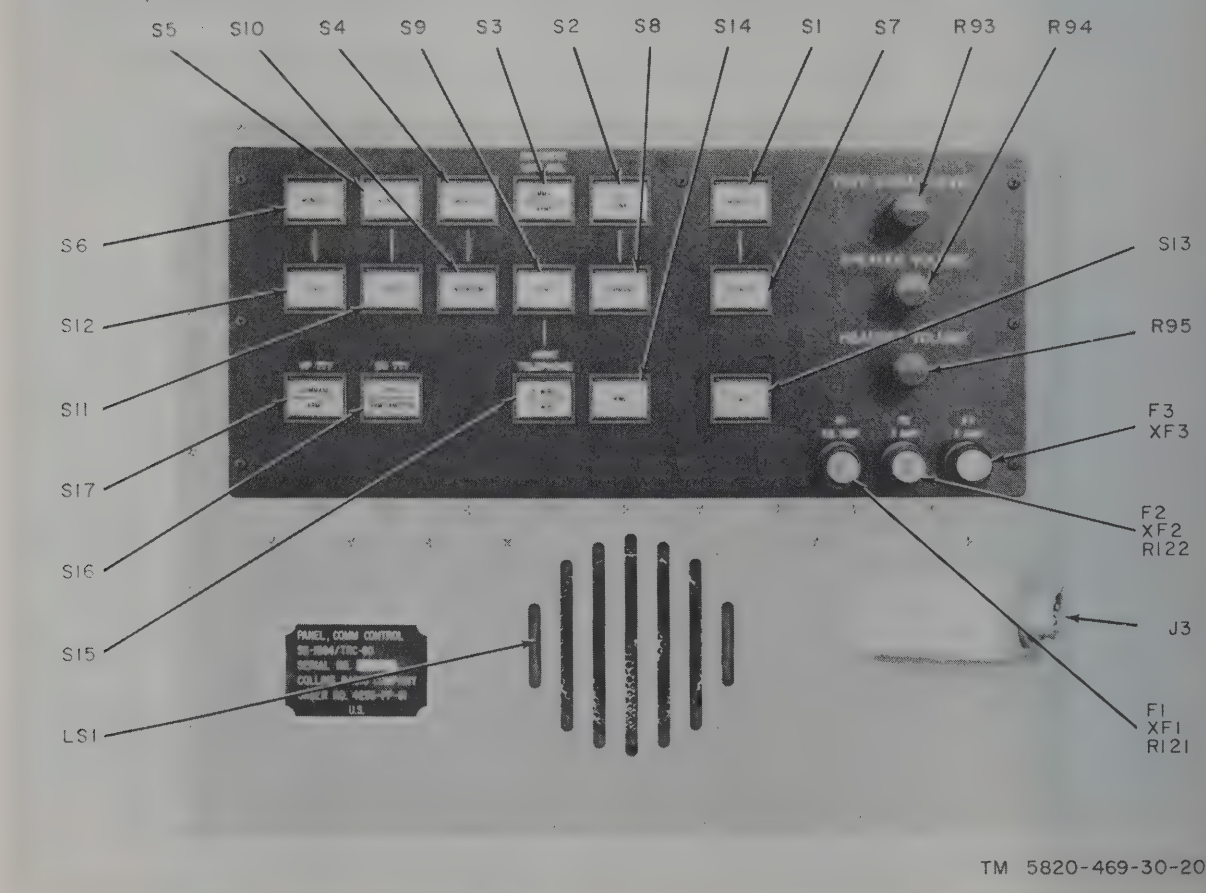


Figure 141. Control panel, location of front panel switches, controls, and fuses.

ent switch settings of the switch panel control panel, and the teletypewriter switch panel.

273. Control Panel Troubleshooting (fig. 141)

Troubleshooting of the control panel at direct support maintenance level is confined to localizing troubles down to the control panel itself. When the recommended procedures at the organization level do not restore normal operation, remove the control panel (para. 41, TM 11–5820–469–20) and replace it with a known good control panel. Repair of the printed circuit boards and other components within the control panel is beyond the capability of direct support maintenance personnel.

274. Teletypewriter Switch Panel Troubleshooting

a. General. In normal use, the only likely source of trouble with the teletypewriter switch panel will be faulty contacts in OPERATING MODE switch S2. Since input and output circuit connections are changed whenever the OPERATING MODE switch is set to another position, the functional diagrams of the teletypewriter switch panel, in addition to the complete schematic diagram (fig. 182), should be used during localizing procedures. The functional illustrations (figs. 16, 17, and 24) and the accompanying text (para. 161) cover the input and output circuit connections that are made in the three positions of the OPERATING MODE switch. When trouble in the teletypewriter switch panel is suspected, follow the procedure given below:

(1) Replace the teletypewriter switch panel with a known good unit. Refer to paragraph 45 of TM 11–5820–469–20 for removal procedures.

(2) If the new teletypewriter switch panel clears the trouble, set the defective unit on a service bench and perform the procedures given in *b* and *c* below.

b. Line Compensation Tests.

(1) Attach the cable connector on the front panel of the teletypewriter test set (test facilities kit fig. 150) to teletypewriter switch panel jack J1 (fig. 142).

(2) Connect the SG–71/FCC, set for a frequency of 1,275 cps, to the INPUT pins of the teletypewriter test set front panel. (This places a 10,000-ohm resistance in series with the SG–71/FCC and prevents loading the hybrid transformer in the tty switch panel.)

(3) Place OPERATING MODE switch S2 in the VF 2W/4W position. Use an ME–30B/U to monitor the level at RX pin jacks J6 and J7 (fig. 142). Adjust the generator to obtain a level of 0 dbm. Move the ME–30B/U leads and monitor TX pin jacks J9 and J10. Terminate these leads with a 619-ohm BNC–GR resistive termination (items 12 and 21 connected together, fig. 150) to simulate the input transformer in the multiplexer which is normally connected at this point.

Note. The most convenient location for the 619-ohm resistive termination is across the ME–30B/U terminals.

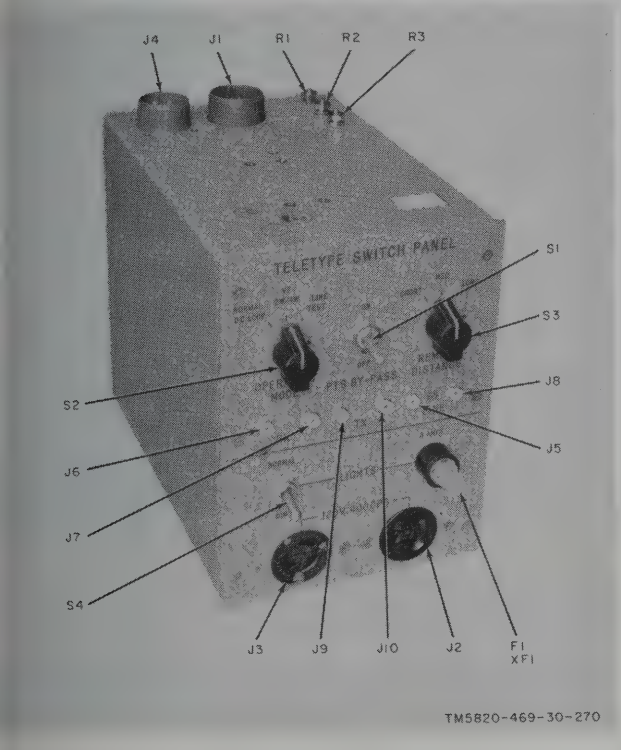


Figure 142. Teletypewriter switch panel, front view location of components.

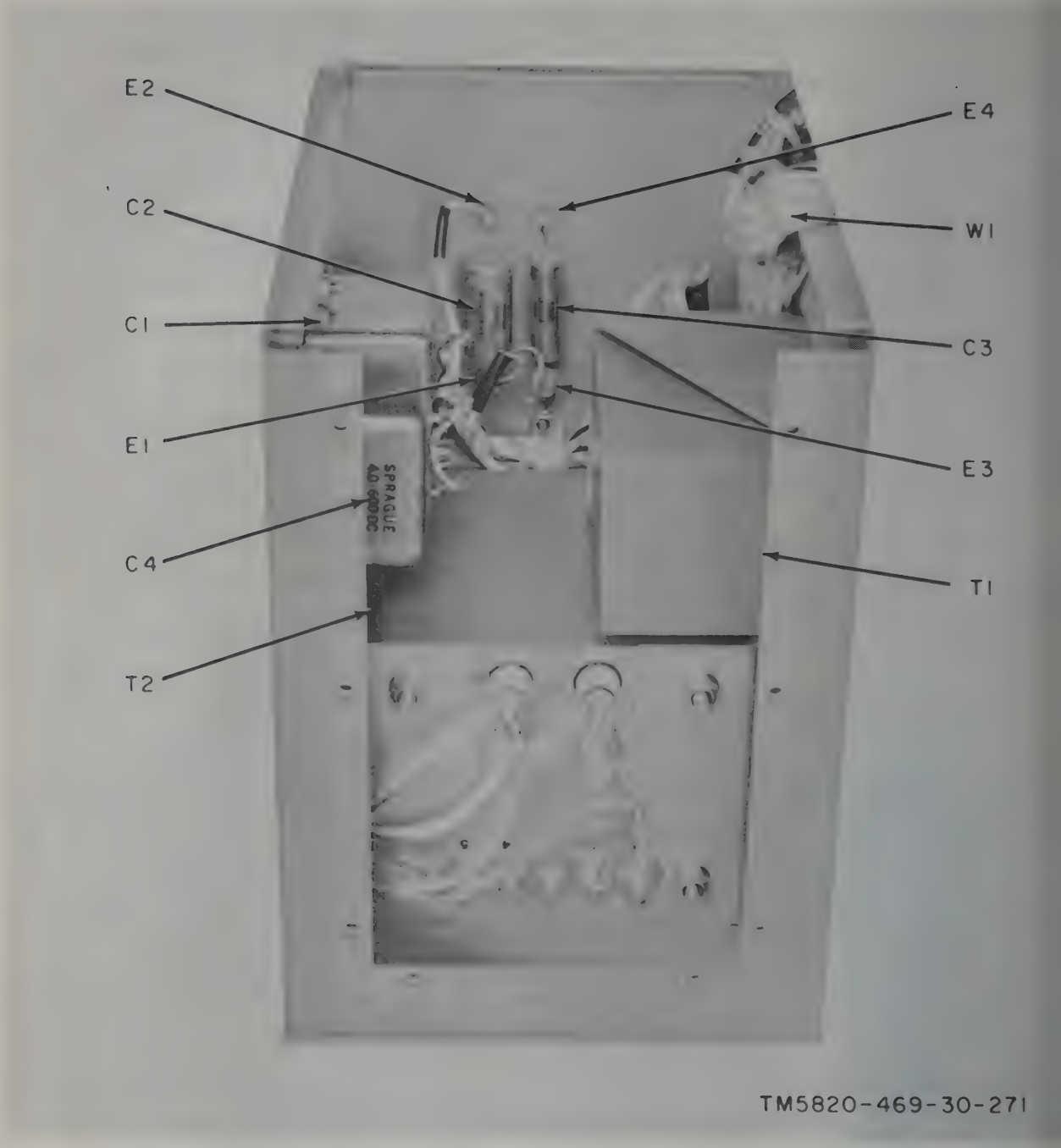


Figure 143. Teletypewriter switch panel, cover removed, rear view.

(4) Place the tty switch panel REMOTE DISTANCE switch in the SHORT position and set the LINE SIMULATOR SELECTOR on the tty test set to SHORT. Adjust R1 (fig. 142) for a minimum reading on the ME-30B/U. The indication should not be greater than —20 dbm.

(5) Place the REMOTE DISTANCE switch in the MED position and set

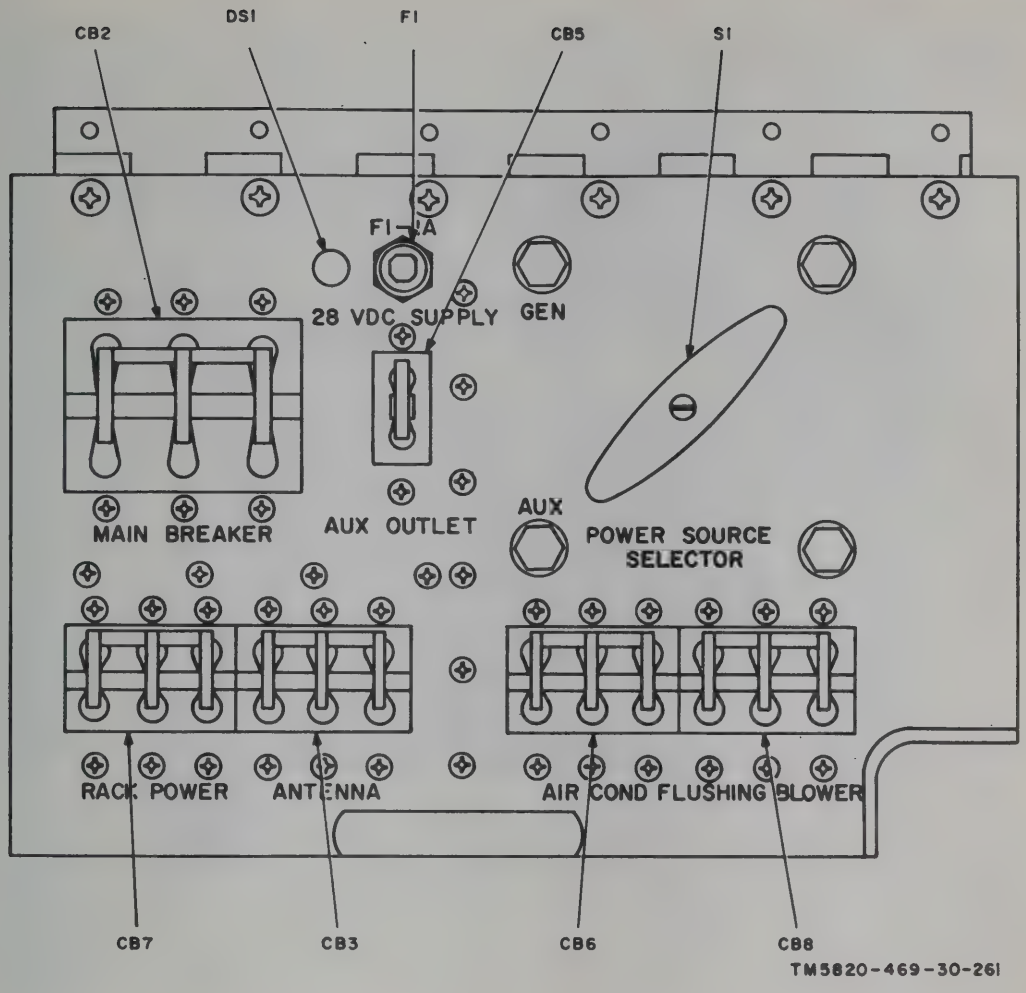


Figure 144. Circuit breaker panel, front view.

the LINE SIMULATOR SELECTOR on the tty test set to MED. Adjust R2 for a minimum reading.

(6) Place the REMOVE DISTANCE switch in the LONG position and set the LINE SIMULATOR SELECTOR on the tty test set to LONG. Adjust R3 for a minimum reading.

(7) If the adjustments given in (4), (5), and (6) above cannot be performed, refer to figure 182 and use the ME-26B/U as an ohmmeter to locate the defective component within the teletypewriter switch panel.

c. Light Transformer and Power Outlet Tests. Check the power circuits of the teletypewriter switch panel by referring to the schematic diagram (fig. 182) and performing continuity measurement. Transformer T2 cannot be operated from 60-cps power which is normally available at the test bench. Power measurements must be made with the unit operating in the shelter. Secondary voltage for the light fixtures should be 11.5 to 14.1 volts ac (measured at J4) for the NORMAL position, and 5.2 to 6.3 volts ac for the DIM position of S4.

275. Circuit Breaker Panel
(figs. 144 and 145)

When trouble is localized to the circuit breaker panel, refer to paragraphs 206 and 207 for a functional description of the panel. Figure 186

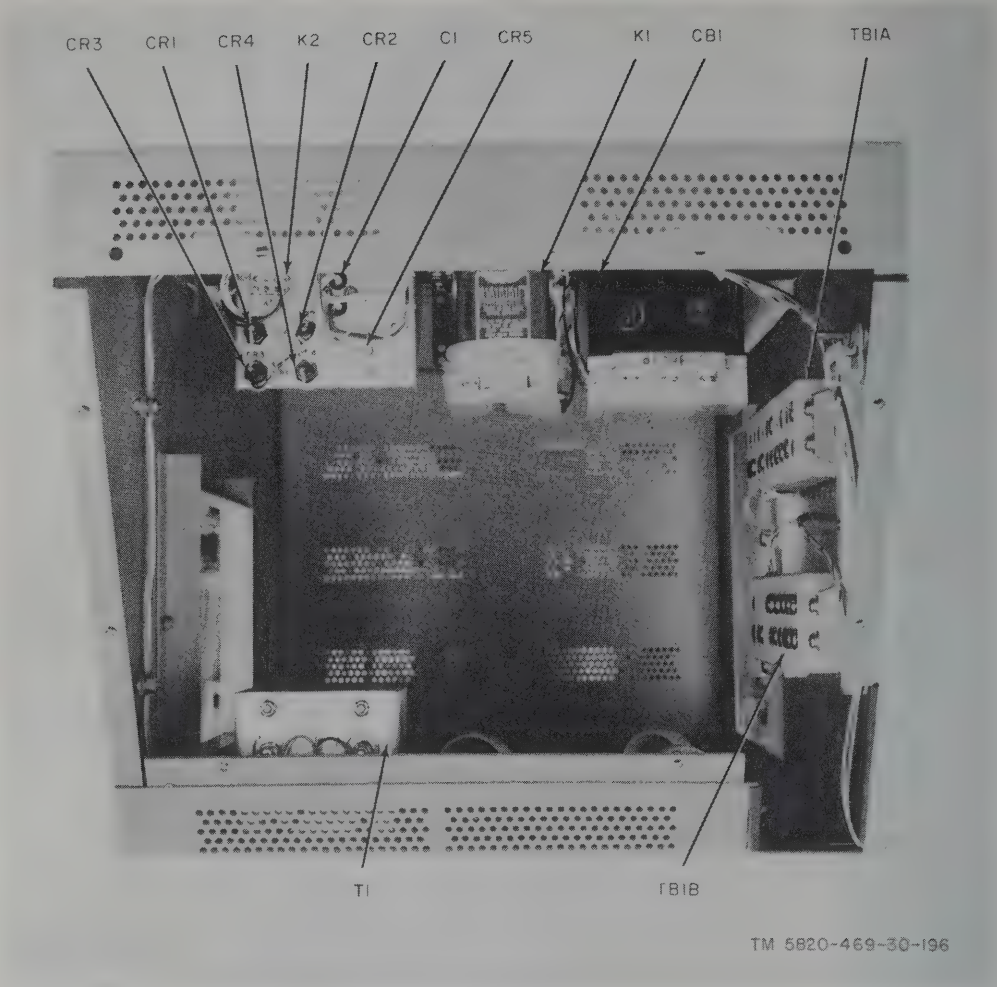


Figure 145. Circuit breaker panel, top view, door removed.

is the complete schematic diagram. Generally, reference to the schematic diagram and the measurement suggested below should be adequate to locate the trouble.

a. +28-Volt Source. When the +28-volt source voltage is missing, check the following components in the 28-volt supply: F1, T1, CR1 through CR5, and C1 and K2.

b. Ac Power Source. When all ac power is missing and the engine generator is functioning normally, check the connections at J1 and the contactors of MAIN BREAKER CB2. When only one ac voltage is missing, check the applicable circuit breaker (FLUSHING BLOWER CB8, RACK POWER CB7, etc) and the associated wiring.

276. Power and Signal Entry Panel and Blower Motor

a. Power and Signal Entry Panel. This panel serves as a tie-point between external signal and auxiliary power equipment and the AN/TRC–80 equipment. When trouble is localized to this panel, turn off all power, refer to the overall wiring diagram (fig. 189), and perform resistance measurements to locate the defective connector.

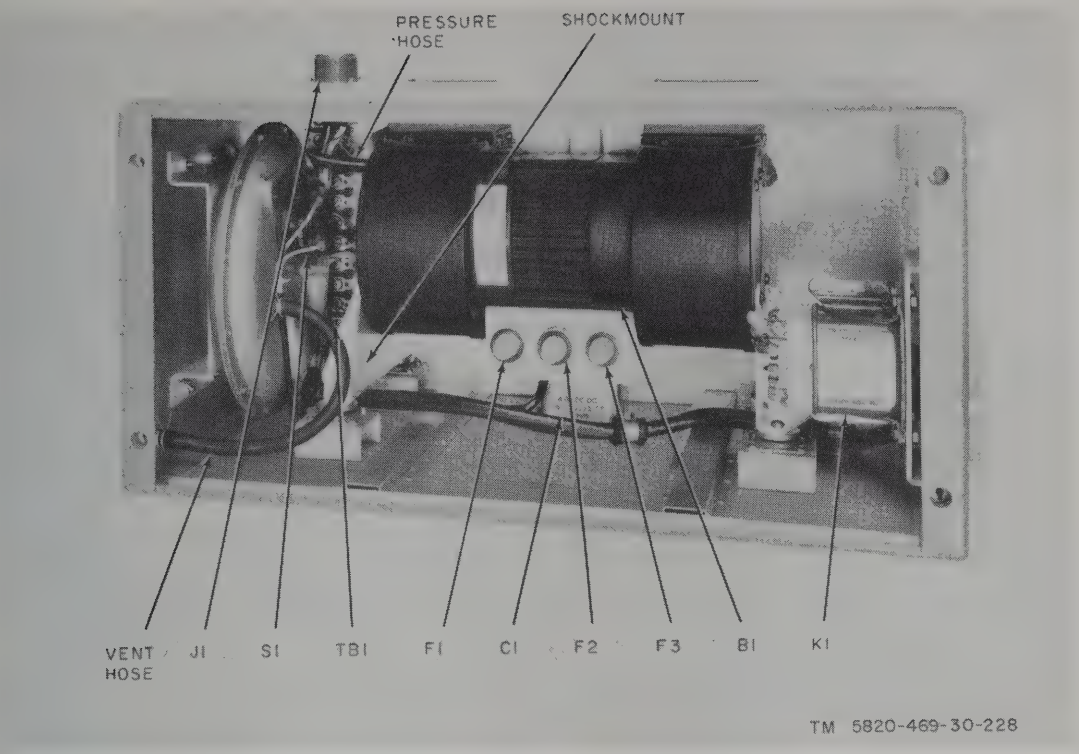


Figure 146. Blower assembly, cover removed, location of components.

b. Blower (fig. 146). The blower and blower motors are not repaired at this maintenance level. When the blower is not functioning and the fuses (F1, F2, and F3) check good, remove the connector from J1 and loosen the four corner-located retaining screws that attach the blower compartment to the rack. Refer to paragraph 286 to remove the blower assembly.

CHAPTER 20

REPAIRS AND ADJUSTMENTS

Section I. REMOVAL AND REPLACEMENT OF COMPONENTS

277. Modulator-Multiplier

Note. Refer figure 67 through 70 for modulation multiplier component location.

a. Control Panel Removal (fig. 67).

(1) Remove 10 retaining screws to gain access to the back of the control panel.

(2) The control panel components are now accessible.

b. Control Panel Replacement.

(1) Reconnect any leads that were tagged and disconnected.

(2) Reinstall the control panel and secure with 10 screws.

c. Disassembly for Access to Inside Chassis Components.

(1) Loosen four screws on the right-hand side of the module and swing it out on the hinges.

(2) Disconnect the input and output connections from the jack panels (fig. 24, TM 11–5820–469–20).

(3) Remove the back cover by removing 35 screws.

(4) Gain access to the rear of the two jacks panels by removing four screws from each jack panel. All inside components are now accessible.

d. Reassembly.

(1) Reinstall the two jack panels and secure each with four screws.

(2) Reinstall the back cover with 35 screws.

(3) Reconnect the input and output connections to the jack panels.

(4) Swing the unit back into place, and secure it with four screws.

e. Power Supply A1 Removal.

Note. Figures 62, 63, and 64 illustrate the minor components in 200-volt power supply A1.

(1) Disassemble as outlined in *c* above.

(2) Remove and tag leads from the five connections to power supply A1.

(3) Remove four nuts from inside chassis on power supply studs.

(4) Remove A1 from the front of the chassis.

f. Power Supply A1 Disassembly.

(1) Perform the procedure given in *e* above.

(2) Remove four recessed hexagonal nuts in base of power supply.

(3) Lift lower (cast) section clear of mounting studs (fig. 62).

Caution: **Be careful not to break leads from solder connections on power supply transformer.**

(4) Remove four screws from covers of component board A101 (fig. 64). All circuit components are now accessible.

g. Power Supply A1 Reassembly.

(1) Replace the component board with four screws.

(2) Replace the lower section on the mounting studs and secure with four hexagonal nuts in base of power supply.

h. Power Supply A1 Installation.

(1) Install A1 from front chassis and secure in place with four nuts.

(2) Reconnect the tagged leads.

(3) Reassemble as outlined in *d* above.

i. Transformer T1 Removal (fig. 67).

(1) Disassemble as outlined in *c* above.

(2) Remove and tag connections from terminals 1 through 6 of T1.

(3) Remove four nuts from inside chassis.

(4) Remove T1 from the front of the chassis.

j. Transformer T1 Replacement.

(1) Install T1 on the front of the chassis and secure it in place with four nuts threaded on the transformer from inside the chassis.

(2) Reconnect the tagged leads (*i*(2) above).

(3) Reassemble as outlined in *d* above.

k. Transformer T2 Removal (fig. 67).

(1) Disassemble as outlined in *c* above.

(2) Disconnect and tag leads from T2.

(3) Remove four nuts from the transformer studs inside the chassis.

(4) Remove T2 from the front of the chassis.

l. Transformer T2 Replacement.

(1) Install T2 on the front of the chassis and secure it in place with four nuts threaded on from the inside the chassis.

(2) Reconnect the tagged leads (*k*(2) above).

(3) Reassemble as outlined in *d* above.

278. Transmit Converter

Note. Figures 46 through 53 illustrate the transmit converter component locations.

a. Meter Panel Removal.

(1) Remove seven screws from periphery of panel.

(2) Remove panel to limit of the cable service loop.

b. Meter Panel Installation.

(1) Reconnect any leads that were tagged and disconnected.

(2) Reinstall the meter panel and secur with seven screws.

c. Disassembly for Access to Inside Chassi Components.

(1) Remove two coaxial connectors (P and P17, fig. 46) on the right end o traveling wave tube V9.

(2) Loosen four captive screws on th right side of the transmit converte chassis, and swing the unit out on th hinges.

(3) Remove three coaxial connectors fro J5, J6, and J7 on the rear of the un (fig. 23, TM 11–5820–469–20).

(4) Remove four screws on the connecto cover and remove the cover.

(5) Tag and remove power connectio leads on TB1 (fig. 47).

(6) Remove 44 screws and remove bac cover.

(7) The majority of chassis-mounted con ponents are now accessible. Access t the components in the high-voltag power supply, is covered in *f* belov

d. Reassembly.

(1) Replace the back cover, securing wit 44 screws.

Note. Start *all* screws before tightening.

(2) Reconnect power leads to TB1.

(3) Replace the connector cover and s cure with four screws.

(4) Reconnect the three coaxial connecto on J5, J6, and J7 at the rear of th unit.

(5) Tighten the captive screws to secu the unit to the rack.

(6) Reconnect coaxial connectors P3 an P17 on the righthand end of th traveling wave tube.

e. Power Supply A1 Removal, Replacemen Disassembly, and Reassembly. Power Supp A1 is identical with unit A1 used in the mod lator multiplier. Adapt the procedures given paragraph 277*e* through *h* for removal, replac ment, disassembly, and assembly.

f. High-Voltage Power Supply Access.

(1) Disassemble as outlined in *c* above.

(2) Remove nine screws and remove high-voltage power supply cover plate. All components of the high-voltage circuit board (fig. 47) are now accessible.

(3) Remove five screws and high-voltage circuit board (fig. 48) to limit of service loop. This provides access to the components under the board.

g. High-Voltage Power Supply Reassembly.

(1) Reinstall the high-voltage circuit board with five screws.

(2) Reinstall the cover plate with nine screws.

(3) Reassemble as outlined in *d* above.

h. Voltage Regulator Tube Removal (fig. 49).

(1) Disassemble as outlined in *c* and *f* above.

(2) Unsolder three tube base leads from printed board.

(3) Remove the spring steel tube shield by pulling it away from the tube holder.

(4) Bend the tube holder apart and remove the tube.

i. Voltage Regulator Tube Replacement.

(1) Place the tube in the tube holder and bend the tube holder around the tube.

(2) Insert the tube leads in the holes in the printed board. Clip and solder the leads to the board.

(3) Replace the spring steel tube shield around the tube holder.

(4) Reassemble as outlined in *d* and *g* above.

j. Oscillator Unit A2 Removal (figs. 46 and 1).

(1) Remove coaxial connector jacks J1 and J2.

(2) Loosen four captive bolts.

(3) Remove the oscillator unit.

k. Oscillator Unit A2 Disassembly.

(1) Perform the procedure given in *j* above.

(2) Remove three screws from each side and the center screw from each end of the module, and remove the bottom cover to the limit of the service loop (fig. 52 illustrates the oscillator unit with the cover removed).

(3) All components are now accessible.

l. Oscillator Unit A2 Reassembly.

(1) Replace the bottom cover, securing it with eight screws.

(2) Replace the oscillator on the transmit converter main frame.

(3) Tighten the four captive bolts.

(4) Reconnect coaxial connectors J1 and J2.

m. Multiplier Unit A3 Removal and Replacement (figs. 246 and 55). Refer to paragraph 50 in TM 11–5820–469–20 for multiplier unit removal, replacement, and disassembly to gain access to tubes. Note that removing the rear cover provides access to all interior components.

n. Varactor Multiplier Unit Removal (figs. 46 and 59).

(1) Perform the disassembly procedures given in *c* above.

(2) Disconnect plug from jack J1.

(3) Remove plug P1 from chassis jack.

(4) Disconnect the plug from jack J2 at the rear of the chassis (fig. 61). (The receive converter rear chassis connection for J2 is illustrated in fig. 73). In the receive converter, loosen the clamp that secures filter FL1 to the chassis and move FL1 upward, as necessary, to remove the connector on J2.

(5) Loosen four captive screws (1, fig. 59) and remove the complete varactor multiplier unit.

o. Varactor Multiplier Unit Disassembly.

(1) Perform the removal procedures given in *n* above.

(2) In the transmit converter varactor multiplier unit, turn the knurled screw (fig. 61) counterclockwise (ccw) and remove. The action ex-

poses the holder for CR1. Grasp the CR1 holder with a pair of long-nose pliers and pull straight up to remove the holder and CR1 from the chassis cavity. (Note the polarity of CR1.)

(3) In the receive converter (fig. 73), remove four screws and remove the CR1 mounting plate.

(4) Remove the input cavity tuning lock retaining screw and turn the input cavity tuning lock counterclockwise to remove.

Caution: **Use extreme care when disassembling the varactor multiplier unit.**

(5) Remove six screws (2, fig. 59) and remove input cavity. Lift the cavity straight up to avoid strain on the probe (fig. 60). Remove the radiofrequency interference (rfi) gasket that is located between the input cavity assembly and the mounting cavity (fig. 60).

(6) Remove 10 screws (1, fig. 60) and carefully lift the mounting cavity straight up, while holding the probe assembly to avoid any strain on resistor R1.

(7) Remove two screws (2, fig. 60) holding the tuning bracket to the bottom plate.

(8) Loosen (do not remove) the two countersunk screws (3, fig. 60) from the end of the bottom tuning assembly mounting posts.

(9) Turn the two posts ccw (alternately) and free the posts from the mounting studs in the bottom plate.

(10) Tune the plunger assembly to the low frequency end.

(11) *Carefully* pull the plunger assembly from the cavity.

(12) Remove four screws and remove the output loop (fig. 61).

(13) Remove the top plate by removal of seven screws (4, fig. 60).

p. Varactor Multiplier Reassembly.

(1) Replace the top plate. Secure with seven screws (4, fig. 60).

(2) Insert the output loop (fig. 61) a secure with four screws.

(3) *Very carefully* insert the plunger a sembly into the bottom cavity. Avo bending the sliding contacts.

(4) Tighten the mounting posts by tur ing clockwise (cw) (alternately) the studs on the bottom plate.

(5) Tighten the two countersunk screv (3, fig. 60) in the end of the moun ing posts.

(6) Replace the two screws (2, fig. 6 holding the tuning bracket to the bo tom plate.

(7) Replace the mounting cavity and gasket. Insure that the assembly sea properly. Secure with 10 screws fig. 60).

(8) Replace the input cavity and rfi ga ket. Be careful not to damage t probe. Secure with six screws (2, f 59).

(9) In the transmit converter, repla diode CR1 within the backplate (f 61). Tighten the knurled screw. I sure that proper polarity of the dio is maintained (cathode end is i serted first).

(10) In the receive converter, replace t diode mounting plate (fig. 73) a secure with four screws.

(11) Replace input cavity tuning lock a lock retaining screw (fig. 59).

q. Varactor Multiplier Replacement.

(1) Replace the varactor multiplier on t chassis. Tighten the four capti screws (1, fig. 59).

(2) Connect jack J2 (transmit converte fig. 61, receive converter, fig. 73).

(3) Insert plug P1 in the chassis jack.

(4) Replace connector on jack J1.

(5) Follow the procedure given in *d* abo to reassemble the transmit converte

r. Traveling Wave Tube Removal.

(1) Disassemble as outlined in *c* above.

(2) Remove the plug from XV9 (fig. 4

(3) Remove the four screws (from the rear of the chassis) that hold the traveling wave tube mounts to the chassis.

(4) Carefully slide the traveling wave tube to the right of the shelf and out of the shelf.

Note. Do not discard defective traveling wave tubes. Retain for disposition instruction.

s. Traveling Wave Tube Replacement.

(1) Carefully slide the traveling wave tube into the chassis. Insure that the tube seats firmly in the foam rubber socket.

(2) Reinsert the four screws that secure the traveling wave tube mounts to the chassis.

(3) Reinsert the plug into socket XV9.

(4) Reassemble as outlined in *d* above.

(5) Refer to paragraph 294*b* for adjustments.

t. Tunable Filter A5 Removal.

(1) Remove plugs P16 and P2 from filter.

(2) Remove four screws from base of filter.

(3) Remove the tunable filter from the chassis.

u. Tunable Filter A5 Replacement.

(1) Replace the tunable filter on the chassis.

(2) Replace the four screws that secure the filter to the chassis.

(3) Reconnect plugs P2 and P16 to the filter.

79. Power Amplifier

The instructions for removing and replacing ıe three power amplifier drawers are con-ıined in TM 11–5820–469–20. The instructions ıven below cover removal and replacement of ɔmponents within the three drawers.

a. Klystron Removal.

Caution: **Remove watches, rings, and identi-cation chains. Keep magnetic materials at ast 6 inches from klystron magnet (this in-udes metal handtools). Keep magnets 12 ıches away from klystron magnet.**

(1) Follow the procedure given in TM 11–5820–469–20 for removal of the klystron drawer. Remove filament connectors P301 and P302 from J301 and J302 (fig. 44) in the power supply. Both directional coupler connectors P204 and P205 must be removed (from J204 and J205) as well as RF input connector P203 (from J203).

(2) Remove both filament connectors (P-301 and P302) from the bottom of the klystron (fig. 45). Do not place stress on the ceramic connectors.

(3) Remove waveguide-to-coaxial adapter CP201 (fig. 44) on the lower waveguide fitting.

(4) Remove the two ground leads from the collector cooling fins and the single lead on the klystron waveguide bracket (fig. 44).

(5) Loosen the support band and remove air vane microswitch S201. Completely remove the screw that holds the lower band (fig. 34, TM 11–5820–459–20).

(6) Turn each cavity tuning control to the low end stop. Loosen the eight setscrews on the four double-joint couplers (fig. 44).

(7) Remove the eight bolts securing the klystron to the vertical brackets (fig. 44). Remove the two right-hand brackets (viewed from the rear) from the chassis. It is not necessary to remove the three plastic cable clamps (fig. 44). Just pull the brackets to the side.

(8) Remove the four bolts which secure the klystron to the chassis. Pull the tube just enough to the right to disengage the cavity controls. Using extreme caution, lift the tube out of its place on the chassis.

Caution: **Do not allow the tube to rest on the cavity tuning controls or the ceramic filament connector.**

b. Klystron Replacement.

(1) Before reinstalling the replacement

klystron, turn all cavity controls fully clockwise by hand; *do not use force.* Examine the waveguide windows to be certain there are no small metallic particles adhering to the surface or wedged in the corners. These particles can cause arcing which will damage the tube.

(2) Carefully place the klystron on the chassis while engaging the cavity controls.

(3) Replace the four bolts which secure the klystron to the chassis.

(4) Replace the right-hand brackets on the chassis.

(5) Replace the eight bolts which secure the klystron to the vertical brackets.

(6) Replace air vane microswitch S201 next to the cooling fins and replace the screw in the lower support band.

(7) Replace the two ground leads on the collector cooling fins and the single lead on the klystron waveguide bracket.

(8) Replace waveguide-to-coaxial adapter CP201 on the lower waveguide fitting.

(9) Replace both filament connectors on the bottom of the klystron (fig. 45).

(10) Replace directional coupler connectors P204 and P205 on J204 and J205.

(11) Replace RF input connector P203 on J203.

(12) Replace filament connectors P301 and P302 in jacks J301 and J302 (fig. 33, TM 11–5820–469–20) in the power supply.

(13) Retighten the double-joint couplers. Verify that one of the setscrews (on each coupler) is properly positioned facing the flat side of the tuner shaft. Tighten both setscrews.

(14) Loosen the left-hand setscrew on the rubber coupler for each counter (rear view). Hold each crank firmly by hand and rotate the corresponding coupler until the counter reads 20. Retighten the setscrew.

Caution: **Prior to reinstalling the klystron drawer, carefully examin the magnet structure. Make certai that no small tools or other parts ar adhering to the tube. Small screw drivers and Allen wrenches can easil distort the magnetic field enough t defocus the beam and cause difficult in tuning as well as excessive bod current.**

(15) Installation is not complete until th front panel counters have been cal brated at mid-band channel 761 fo the tube just installed. Refer to para graph 292 and perform the procedure in subparagraphs *a* through *d*.

c. Klystron Drawer Components.

(1) *Attenuator AT201 removal.*

(*a*) Remove the four attenuator secu ing screws from the bottom of th chassis.

(*b*) Loosen the two Allen setscrews o the drive shaft.

(*c*) Remove the coaxial cable connector

(*d*) Remove the attenuator.

(2) *Attenuator AT201 replacement.*

(*a*) Set the attenuator in place on th chassis.

(*b*) Replace the coaxial cable connector

(*c*) Secure the two Allen setscrews o the drive shaft.

(*d*) Secure the attenuator to the chass with the four screws.

(3) *Directional coupler (input) DC20 removal* (fig. 44).

(*a*) Remove the four coaxial cable co nectors that are connected to DC 201.

(*b*) Remove the two securing screw from the bottom of the chassis.

(*c*) Remove directional coupler DC20

(4) *Directional coupler (input) DC201 r placement* (fig. 44).

(*a*) Set directional coupler DC201 i place on the chassis.

(*b*) Replace the two securing screws.

(*c*) Replace the four coaxial cable co nectors.

(5) *Output directional coupler DC202 r moval.* Refer to figure 29.

Note. The numbers in parentheses in these instructions pertain to the numbers on figure 29 (Part 1).

(*a*) Remove the control panel drawer (para. 43, TM 11-5820-469-20).

(*b*) Remove the two coaxial cables from directional coupler DC202.

(*c*) Remove the eight screws (6) and lockwashers from the output waveguide flange at the top of the cabinet.

(*d*) Using an offset screwdriver, remove the rear coupler support bracket screw (1) that holds one side of the rear coupler support bracket (3) in place.

(*e*) Through the access hole (7) provided in the cabinet top, remove the other bracket retaining screw (2) that supports the other side of the bracket (3). Removal of the two screws (1 and 2) allows the rear coupler support bracket (3) to be removed by sliding it backward slightly and then down.

(*f*) Remove eight retaining screws (9), flatwashers, lockwashers, and nuts holding the bottom flange of filter FL201 to the section of the flexible waveguide.

(*g*) Using an offset screwdriver, remove the eight retaining screws (10), flatwashers, lockwashers, and nuts that hold the bottom flange of directional coupler DC202 to the top flange of filter FL201.

(*h*) Using an offset screwdriver, remove the six mounting screws (4) that hold the FL201 bracket (8).

(*i*) Carefully remove filter FL201.

(*j*) Slide directional coupler DC202 to the rear slightly (about 1 or 2 inches) so that the upper flange clears the flange bracket (5), and carefully lower DC202 and withdraw it.

(6) *Output directional coupler DC202 replacement* (fig. 29).

Caution: **Be sure that the directional coupler is installed with the arrow pointing up.**

(*a*) Insert directional coupler DC202 so that the upper flange slides between the flange bracket (5) and the top of the cabinet.

(*b*) Insert filter FL201 and connect the bottom flange to the flexible waveguide section with eight securing screws (9), flatwashers, lockwashers, and nuts.

(*c*) Replace the rear coupler support bracket (3) by sliding it into position from the rear of directional coupler DC202.

(*d*) Replace the screws (① and ②, fig. 29 (Part 1)) in the rear support bracket (3).

(*e*) Secure the output waveguide flange and upper flange of directional coupler DC202, using the eight retaining screws (6) and lockwashers. (The screws fasten into brackets (3) and (5).)

(*f*) Connect the lower flange of directional coupler DC202 to the upper flange of filter FL201, using the eight retaining screws (9), flat washers, lockwashers, and nuts.

(*g*) Replace filter FL201 support bracket (8), using the six screws (4) and lockwashers.

d. Klystron Blower Removal (fig. 29). To remove the klystron blower, move the power amplifier cabinet away from the wall ((1) through (9) below) and expose the rear of the cabinet.

(1) Remove the control panel, klystron, and power supply drawers (para. 43, TM 11-5820-469-20).

(2) Remove the four screws and lockwashers that hold the pa stowage box (fig. 2, TM 11-5820-469-10) to the shelter ceiling and remove the stowage box.

(3) Remove the input power plug from jack J1 (fig. 29 (Part 1)) and the plug from jack J3 at the top of the pa cabinet.

(4) Remove the three clamps at the top of the cabinet that hold the cabinet to the shelter wall.

(5) Remove the eight screws (6) and lockwashers that connect the output waveguide and the ground cable to the pa.

(6) Remove the eight base securing bolts (11) that hold the base of the cabinet to the floor of the shelter.

(7) Swing the teletypewriter table clockwise against rack A3 to provide room for the pa cabinet.

(8) Pull the pa cabinet away from the corner at a 45° angle. Be careful to avoid damage to the gaskets around the two ventilation ports.

(9) Position the cabinet to provide access to the rear.

(10) Remove the rear cover from the cabinet.

(11) Remove and tag the power and ground connections to the blower power connection box.

(12) Remove the circular clamp that holds the canvas inlet duct to the blower assembly by removing the clamp screw.

(13) Remove the four support bolts that secure the blower assembly to the shock mounts and remove the blower.

e. Klystron Blower Replacement.

(1) Secure the blower to the shock mounts, using four support bolts.

(2) Connect the canvas inlet duct with the circular clamp, and tighten the clamp screw.

(3) Connect the power and ground wires to terminals in the blower power connection box.

(4) Replace the rear cover of the cabinet.

(5) Slide the pa cabinet into the corner at a 45° angle. Be careful to avoid damage to the gaskets around the two ventilation ports.

(6) Secure the base of the cabinet to the shelter floor, using the eight base securing bolts (11).

(7) Connect the output waveguide flan and the ground cable to the pa, usi the eight screws (6) and lockwashe

(8) Secure the top of the cabinet to t shelter wall, using the three clamps.

(9) Connect the input power plug to ja J1 and the coaxial plug to jack J3 the top of the cabinet.

(10) Replace the power supply, klystro and control panel drawers (para. 4 TM 11–5820–469–20).

(11) Mount the pa stowage box to t shelter ceiling with the four scre and lockwashers.

280. Monitor

a. Disassembly for Access to Inside Co ponents.

(1) Insure that all power is removed fro the unit.

(2) Loosen two captive screws on t right-hand side of the monitor.

(3) Swing the unit out of the hinges.

(4) Remove 14 screws and remove t back cover.

(5) Remove four screws and remove t protective plate that covers TB1 (f 135).

(6) Disconnect the power input to t terminal board TB1.

(7) Remove the coaxial connectors fro jacks J1 through J8 (fig. 22, TM 1 5820–469–20).

(8) Remove four screws and remove t jack panel to the limit of the servi loop.

(9) Remove four screws from the met component mounting board th mounts R70, R71, etc. (fig. 135), a lift the lower edge of the mountin board to the limit of the servic loop.

(10) The procedure given in (8) and (above is necessary only for access components mounted on or under t jack panel or mounting board.

. Reassembly.
(1) Replace the metal component mounting board and secure it with four screws.
(2) Replace the jack panel and secure it with four screws.
(3) Replace the coaxial connectors to J1 through J8.
(4) Reconnect the power input leads to terminal board TB1.
(5) Replace the protective cover on TB1 and secure with four screws.
(6) Replace the back cover and secure with 14 screws.
(7) Swing the unit into place on the rack and secure it with the two captive screws.

. Meter Panel Removal (fig. 133).
(1) Remove nine screws from the periphery of the meter panel.
(2) Remove the panel to the limit of the service loop.

l. Meter Panel Replacement.
(1) Place the meter panel in place.
(2) Secure the meter panel with the nine screws.

. Power Transformer Removal (figs. 133 l 137).
(1) Perform the disassembly procedure given in *a*(1) through (7) above.
(2) Remove and tag 11 wires that connect to T1.
(3) Remove four nuts from the transformer studs.
(4) Remove the power transformer from the front of the unit.

. Power Transformer Replacement.
(1) Insert the transformer and secure it with four nuts.
(2) Connect and solder the 11 tagged wires.
(3) Perform the reassembly procedures given in *b* above.

1. Multiplexer

a. Disassembly for Access to Inside Chassis mponents.

***Warning:* Be sure all power is removed from e multiplexer.**

(1) Loosen the captive screws on the right-hand side of the unit and swing the unit out on its hinge.
(2) Disconnect the eight coaxial connectors (J1 through J8) and three cable connectors (J9 through J11 (fig. 130)).
(3) Remove the four screws from the protective plate on terminal board TB2.
(4) Remove the ac input wires from terminal board TB2.
(5) Remove the 29 back panel securing screws and remove the back panel.
(6) Remove the four jack panel securing screws and pull the jack panel to the limit of the service loop. All components are now accessible.

b. Reassembly.
(1) Replace the jack panel to its original position and secure it with the four securing screws.
(2) Replace the back panel and secure it with the 29 screws.
(3) Replace the ac input wires on terminal board TB2.
(4) Replace the protective plate on terminal board TB2 and secure it with four screws.
(5) Reconnect the eight coaxial connectors and three cable connectors.
(6) Swing the unit back into position and secure it with the captive screws.

c. Power Supply.
(1) *Printed circuit board TB1 removal.*
(*a*) Remove the six securing screws.
(*b*) Remove the board to the limit of the service loop.
(*c*) Tag and unsolder the wires.
(2) *Printed circuit board TB1 replacement.*
(*a*) Solder the wires to the terminal board as tagged.
(*b*) Replace the board to its original position.
(*c*) Secure terminal board TB1 with the six securing screws.

282. Receive Converter

a. Control Panel Removal (figs. 71 and 72).

(1) Remove the eight screws from the periphery of the control panel.

(2) Tilt the bottom of the control panel out and up so that the back of the panel is facing outward.

(3) Align the four screw holes of the panel to correspond to the four upper screw holes in the panel mount.

(4) Insert the two screws to secure the panel in this position for services. All panel-mounted components are now exposed.

b. Control Panel Replacement (figs. 71 and 72).

(1) Remove the two screws that secure the panel in the service position.

(2) Tilt the control panel down to its normal position.

(3) Replace the eight securing screws to retain the panel.

c. Disassembly for Access to Inside Chassis Components.

(1) Remove all power from the unit.

(2) Remove the connector from jack J1 (fig. 71) of the waveguide input.

(3) Remove the six screws from the waveguide flange (fig. 71).

Note. Use an offset screwdriver to gain access to the rear screws.

(4) Remove the injector portion of the waveguide.

(5) Loosen the four captive screws on the right-hand side of the shelf.

(6) Swing the unit out on its hinges.

(7) Remove the connectors from jacks J2, J3, and J4 (fig. 73).

(8) Remove the 37 securing screws and remove the rear cover.

(9) All chassis-mounted components are now accessible.

d. Reassembly.

(1) Replace the rear cover and secure it with the 37 screws.

(2) Replace the connectors on jacks J2 J3, and J4 (fig. 73).

(3) Swing the unit back to its normal po sition and secure it with the four cap tive screws.

(4) Replace the injector portion of wave guide and replace the six screws t the waveguide flange (fig. 71).

(5) Replace the connector to jack J1 of th waveguide input.

e. Multiplier Unit. For removal, replace ment, disassembly, and reassembly of the mu tiplier unit, (para. 50 TM 11–5820–469–20)

f. Oscillator Unit. For removal, disassembly and reassembly of the oscillator unit, refer t paragraph 278*j*, *k*, and *l* above, and adap those procedures for this unit.

g. Varactor Multiplier Unit. For remova disassembly, and reassembly of the varacto multiplier unit, refer to paragraph 278 through *q* above.

h. RF Preamplifier Removal.

(1) Remove connectors P11 and P5 (fi 71) from jacks J1 and J5 (fig. 82 on the front of the unit.

(2) Loosen the four captive mountin bolts.

(3) Remove connector P1 (fig. 82) fro the jack at the top of the unit.

(4) Remove the unit.

i. RF Preamplifier Disassembly.

(1) Remove the RF preamplifier (above).

(2) Remove the 15 cover screws and r move the cover.

(3) All components are now accessib except tubes V1 and V2.

(4) Remove tubes V1 and V2 (fig. 82) follows:

(*a*) Remove the two securing screw and the protective shield from t tube to be removed.

(*b*) Remove the tube from the socke Avoid undue strain on the ceram portions of the tube.

. RF Preamplifier Reassembly.

(1) Replace tubes V1 and V2 (fig. 82) as follows:
  (*a*) Replace the tubes in the socket. Avoid undue strain on the ceramic portions of the tubes.
  (*b*) Replace the protective shields on the tubes and replace the two screws securing each tube.

(2) Replace the cover and secure with 15 cover screws.

(3) Replace the unit on the receive converter chassis and reconnect connector P1 at the top of the unit.

(4) Secure the unit with the four captive mounting bolts.

(5) Replace the connectors to jacks J1 and J5.

. Tuneup Oscillator Removal.

(1) Remove connectors P10, P9, and P8 (fig. 71) from jacks J1, J2, and J3 (fig. 77).

(2) Loosen the coaxial connector between attenuator AT1 (fig. 71) and the coaxial-to-waveguide adapter.

(3) Loosen the four captive screws securing the unit.

(4) Remove the tuneup oscillator.

. *Tuneup Oscillator Disassembly* (figs. 78 1 79).

(1) Remove the tuneup from the receive converter chassis (*k* above).

(2) Remove the eight securing screws and remove the bottom plate.

(3) All components except the mixer crystal are now accessible.

(4) To remove mixer crystal A1CR1:
  (*a*) Remove the small screw from the bottom of the crystal holder.
  (*b*) Bend the plate away from the crystal holder.
  (*c*) Unscrew the shell from the crystal holder.
  (*d*) With the fingernails, remove the crystal from the insulated socket.

m. Tuneup Oscillator Reassembly (figs. 78 and 79).

(1) To replace mixer crystal A1CR1:
  (*a*) Insert the crystal in the crystal holder.
  (*b*) Replace the shell on the crystal holder.
  (*c*) Bend the plate back in place.
  (*d*) Replace the screws in the bottom of the crystal holder.

(2) Replace the bottom plate on the module and secure with the eight screws.

(3) Replace the module on the receive converter chassis and secure with four captive screws.

(4) Secure the coaxial connector between attenuator AT1 and the coaxial-to-waveguide adapter.

(5) Replace the connectors on jacks J1, J2, and J3.

n. Preselector A6 Removal (fig. 71).

(1) Obtain access to the rear of the chassis (*c* above).

(2) Remove the seven screws (1, fig. 71) securing phase shifter A7 to waveguide preselector A6. An angle screwdriver is required.

(3) Remove the six screws (fig. 73, (Part 1)) securing the preselector to the shelf.

(4) Remove the preselector.

o. Preselector A6 Replacement.

(1) Replace the preselector and secure to the chassis with the six mounting screws.

(2) Replace the seven screws securing the phase shifter to the waveguide preselector.

p. Phase Shifter A7 Removal.

(1) Remove seven screws (1, fig. 71) securing the phase shifter to the waveguide preselector.

(2) Remove six screws (2, fig. 71) securing the phase shifter to waveguide balanced mixer A8.

(3) Remove the phase shifter.

q. Balanced Mixer A8 Removal.

(1) Remove connectors P15 and P13 (fig. 71) from jacks J2 and J3 on A8.

(2) Remove six screws (2, fig. 71) securing mixer A8 to phase shifter A7.

(3) Remove four screws (3, fig. 71) securing the bracket holding mixer and waveguide-to-coaxial transition A5 to the chassis plate.

(4) Loosen jack J1 to the RF preamplifier and the jack supplying the local oscillator signal. As the jacks are loosened, lift mixer A8 and waveguide-to-coaxial transition A5 to allow removal of the jacks.

(5) Remove the mixer and waveguide-to-coaxial transition.

(6) Remove the bracket from the mixer and the waveguide-to-coaxial transition.

(7) Remove the six screws (4, fig. 71) securing the mixer to the waveguide-to-coaxial transition, and separate the two items.

r. Balanced Mixer A8 Replacement.

(1) Secure mixer A8 to waveguide-to-coaxial transition A5, using the six screws (*q*(7) above). Replace the two items on the bracket.

(2) Hold the mixer and transition slightly above the normal position and start the connections to the local oscillator and the rf preamplifier.

(3) Tighten the connectors, allowing the mixer and transition to lower to the normal position.

(4) Replace the six screws (2, fig. 71) securing mixer A8 to phase shifter A7.

(5) Replace four screws (3, fig. 71) securing the bracket to the chassis.

(6) Replace connectors P15 and P13 on jacks J2 and J3.

s. Waveguide-to-Coaxial Transition A5 Removal.

(1) Remove the six screws securing A5 to waveguide balanced mixer A8 (fig. 71).

(2) Loosen but do not remove the capti bolts securing the tuneup oscillator the shelf.

(3) Loosen the coaxial connector betwe attenuator AT1 (fig. 71) on the tun up oscillator and transition A5. Allo the oscillator to move down to provi clearance to remove the coaxial co nector.

(4) Remove waveguide-to-coaxial trans tion A5.

t. Waveguide-to-Coaxial Transition A5 R placement.

(1) Place the adapter in its approxima location and secure the connector b tween the tuneup oscillator and t adapter.

(2) Replace six screws (3, fig. 71) secu ing transition A5 waveguide balanc mixer A8.

(3) Secure the captive bolts securing t tuneup oscillator to the receive co verter chassis.

283. IF Amplifier

a. Disassembly for Access to Connectors.

(1) Remove the dust cover.

(2) Loosen the four captive screws on t right-hand side of the unit and swi the unit out on the hinges.

b. Reassembly.

(1) Swing the unit into position on t rack and secure with the four capti screws.

(2) Replace the dust cover.

c. Module Removal (A1–A5, fig. 75).

(1) Loosen the four captive bolts.

(2) Pull the module forward evenly.

d. Module Replacement (A1–A5).

(1) Replace the module in the rack; insu that the connectors mate properly a that the guide pins are seated c rectly.

(2) Tighten the four captive bolts.

Discriminator-Combiner Module 2A5 Dis-
mbly.

(1) Remove the module as described in *c* above.

(2) Remove 12 screws from each side (figs. 119 and 120) and remove the side covers.

(3) To gain access to components mounted on circuit boards, unsolder and tag the wires to circuit board TB1 (fig. 120) or TB2 (fig. 119).

(4) Remove the four screws from the board being removed.

Discriminator-Combiner Module 2A5 Re-
mbly.

(1) Mount the printed circuit board to the mounting posts and secure with four screws.

(2) Connect and solder the tagged wires to the printed circuit board.

(3) Replace the side covers and secure them with 24 screws.

(4) Replace the module on the chassis as described in *d* above.

. 8-Mc IF Amplifier No. 2 Module 2A4 Dis-
mbly.

(1) Remove the module from the chassis as described in *c* above.

(2) Remove eight screws from each side (figs. 112 and 113 (Part 2)). Tilt the cover away from the module to expose the cover-mounted components.

(3) Remove the screws and nuts securing the circuit board to the left side cover (fig. 112) and remove the left side cover.

(4) Tag and unsolder the leads to the circuit board.

. 8-Mc IF Amplifier No. 2 Module 2A4
ssembly.

(1) Reconnect and solder the tagged leads to the circuit board.

(2) Mount the printed circuit board to the left side cover and secure with the screws and nuts (*g*(3) above).

(3) Replace and secure both side covers with the screws (*g*(2) above).

(4) Replace the module in the chassis as described in *d* above.

i. 8-Mc IF Amplifier No. 1 Module 2A3 Disassembly. Adapt the procedures given in *g* and *h* above to disassemble and reassemble module 2A3. Refer to figures 104 through 109 for component location.

j. Modules 2A2 and 2A1, Disassembly and Reassembly. Remove and replace these modules as described in *c* and *d* above. The disassembly and reassembly of these two modules is obvious. Access to all components is obtained by removing the side covers from the modules. Parts location for module 2A1 is provided in figures 93, 94, and 95; parts location for 2A2 is provided in figures 97 through 102.

284. IF Power Supply

a. Disassembly for Component Access.

(1) Loosen the four captive screws on the right-hand side of the power supply and swing the unit out on its hinge.

(2) Remove the power plug from jack J5 (fig. 126).

(3) For access to the fuseholders and lampholders, remove the 10 screws from the periphery of the meter panel (fig. 74) and pull out the panel to the limit of the service loop.

(4) Remove the 40 screws securing the rear cover, and remove the cover.

b. Reassembly.

(1) Replace the rear cover and secure it with the 40 screws.

(2) Replace the front panel and secure it with the 10 screws.

(3) Connect the power plug to jack J5.

(4) Swing the unit back into position and secure it with the four captive screws.

c. Power Supply A1, A2, or A3 Removal, Disassembly, and Reassembly.

(1) Perform the disassembly procedure (*a* above).

(2) Remove and tag the five wires from the rear terminal strip of the power supply module to be removed (fig. 126).

(3) Remove the four elastic nuts from the back of the power supply units and remove the front. Adapt the procedure given in paragraph 277*f* and *g* to disassemble and reassemble the power supply units.

d. Power Supply A1, A2, or A3 Replacement.

(1) Place the power supply module on the main chassis.

(2) Replace the four elastic nuts to secure the power supply module to the chassis.

(3) Perform the reassembly procedure (*b* above).

285. Receive Converter Power Supply
(fig. 86)

a. Disassembly for Component Access.

(1) Loosen the two captive screws on the right-hand side of the power supply and swing the unit out of its hinge.

(2) Remove the power plug from jack J4 (fig. 90 (part 1)) on the unit.

(3) For access to the control panel components, remove the 10 screws from the periphery of the front panel and pull out the panel to the limit of the service loop.

(4) Remove the 22 screws securing the rear cover, and remove the cover.

b. Reassembly.

(1) Replace the rear cover and secure with the 22 screws.

(2) Replace the front panel and replace the 10 screws.

(3) Connect the power plug to the unit.

(4) Swing the unit back into position and secure with the four captive screws.

c. Printed Circuit Board Removal (fig. 90 (part 1)).

(1) Remove the three screws securing the board to the standoffs.

(2) Remove the board to the limit of th connecting wires.

(3) Unsolder and tag the five connectin wires.

(4) Remove the printed circuit board.

d. Printed Circuit Board Replacement.

(1) Solder the connecting wires, as tagge to the printed circuit board.

(2) Place the circuit board back into po sition against the standoffs and se cure with the three screws.

e. Power Supply A1 Removal.

(1) Perform the disassembly procedur (*a* above).

(2) Remove and tag the five wires fro terminal board TB1 (fig. 90 (par 1)).

(3) Remove the four elastic nuts from th back of the power supply module.

(4) Remove the power supply module.

f. Power Supply A1 Disassembly. Disas semble power supply A1 as outlined in para graph 277*f*.

g. Power Supply A1 Reassembly. Assembl power supply A1 as outlined in paragrap 277*g*.

h. Power Supply A1 Replacement.

(1) Place the power supply module on th main chassis.

(2) Replace the four elastic nuts to secur the power supply module to the cha sis.

(3) Replace the five wires on TB1 (fi 90 (part 1)).

(4) Perform the reassembly procedure (above).

286. Blower
(fig. 146)

Note. Removal and replacement of the comple blower assembly is covered in paragraph 46 of TM 1 5820-469-20.

a. Pressure Switch S1 Removal.

(1) Perform the procedures given in par graph 46*a* of TM 11-5820-469-20

(2) Remove the vent hose leading from the switch assembly to the side of the case.

(3) Remove the pressure hose from the blower.

(4) Remove and tag two wires from switch S1.

(5) Remove four screws that secure pressure switch S1 to the side of the case.

(6) Remove the pressure switch assembly.

b. Pressure Switch S1 Replacement.

(1) Replace pressure switch S1 in the case and secure it with four screws.

(2) Reconnect the two wires (*a*(4) above) to switch S1.

(3) Connect the pressure hose from the blower. Be sure that a pressure-tight seal is accomplished.

(4) Replace the vent hose.

(5) Replace the blower assembly as outlined in paragraph 46*b* of TM 11–5820–469–20.

c. Relay K1 Removal.

(1) Remove the blower as outlined in paragraph 46*a* of TM 11–5820–469–20.

(2) Remove six screws holding the relay to the right-hand side of the case.

(3) Remove and tag the wires to the relay.

(4) Remove relay K1.

d. Relay K1 Replacement.

(1) Connect the tagged wires to the relay.

(2) Secure the relay to the right-hand side of the case with six screws.

(3) Replace the blower as outlined in paragraph 46*b* of TM 11–5820–469–20.

e. Blower Motor B1 Removal.

(1) Remove the blower as outlined in paragraph 46*a* of TM 11–5820–469–20.

(2) Remove pressure switch S1 as described in *a* above.

(3) Remove the center screw and nut on each shockmount.

(4) Remove the blower to the limit of the service loop.

(5) Remove the screw and nut on the cable clamp to give a longer service loop.

(6) Remove and tag the wires to blower motor B1.

(7) Remove the blower motor.

f. Blower Motor Replacement.

(1) Place the blower motor in the case. Connect and solder the tagged wires.

(2) Secure the cable clamp.

(3) Secure the blower motor to the shockmounts.

(4) Replace the pressure switch as described in *b* above.

(5) Replace the blower as outlined in paragraph 46*b* of TM 11–5820–469–20.

287. Switch Panel
(fig. 139)

a. Disassembly for Access to Chassis Components.

(1) Loosen the two captive screws on the right-hand side of the unit.

(2) Swing the unit out on the hinges.

(3) Remove 11 screws and remove the rear panel.

(4) Remove the plugs from jacks J13 and J14 (fig. 26, TM 11–5820–469–20).

(5) Remove coaxial connectors J1 through J7 (fig. 26, TM 11–5820–469–20).

(6) Remove six screws from the jack panel, and remove the panel to the limits of the service loop.

(7) All components are now accessible.

b. Reassembly.

(1) Replace the jack panel and secure with six screws.

(2) Replace the plugs in jacks J1 through J7 and J13 and J14 (fig. 26, TM 11–5820–469–20).

(3) Replace the rear panel and secure it with 11 screws.

(4) Swing the unit into place and secure with the two captive screws.

288. Antenna
(figs. 147 and 148)

a. Blower Removal (fig. 147).

(1) Disconnect power plug (3).

(2) Remove the two power cable clamps behind the blower (not shown).

(3) Remove four securing screws (1).

(4) Remove four securing screws (2) and remove the blower.

b. Blower Replacement (fig. 147).

(1) Position the blower and insert four securing screws (2).

(2) Insert four securing screws (1).

(3) Tighten all screws.

(4) Install the two power cable clamps (not shown).

(5) Connect power plug (3).

Note. Grease fitting (4) for the righ hand side of the compressor is shown wit the cap in place. The cap should only b removed for lubrication.

c. Compressor Removal (fig. 148).

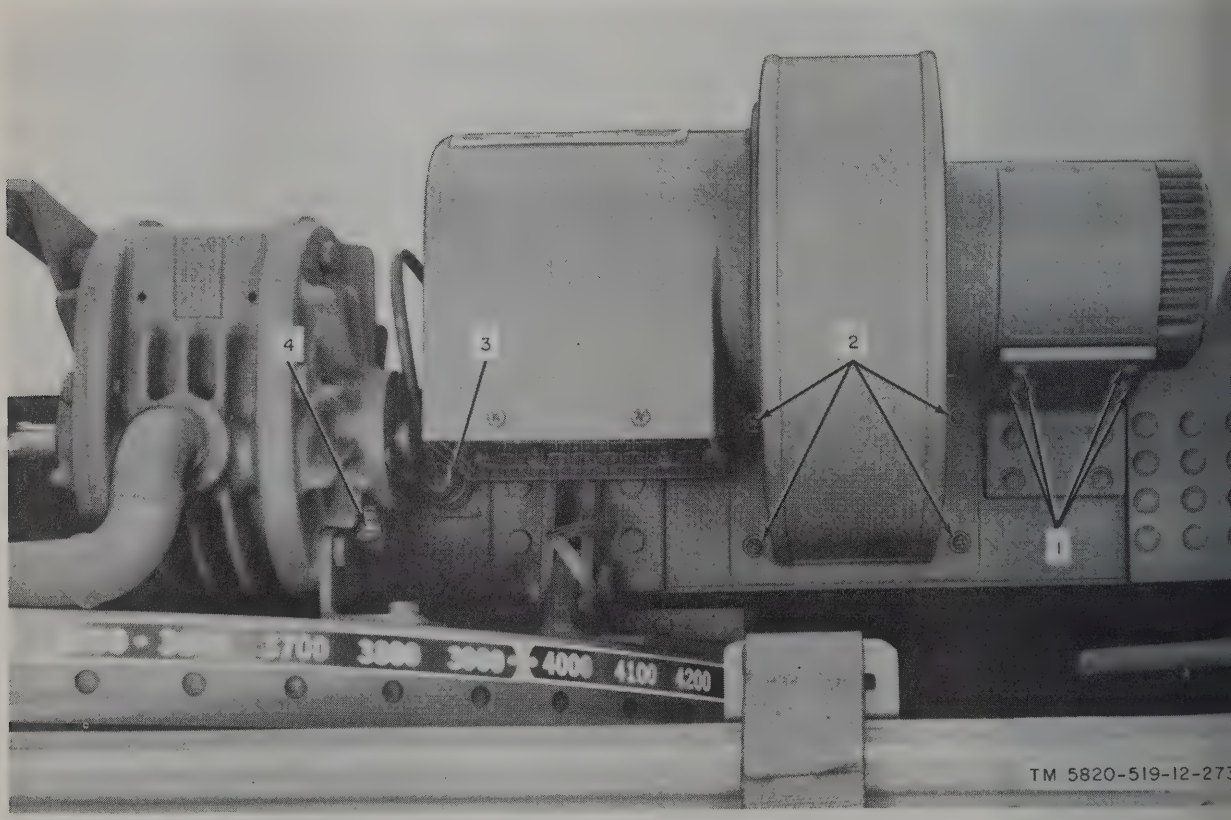
(1) Remove four flathead screws (1) an remove the guard plate over the cou ling.

(2) Remove air filter case retaining scre (2) and remove the air filter case.

(3) Remove power plug (4).

(4) Remove four compressor motor secu ing bolts (5).

(5) Loosen mating coupler setscrew (6 and slide the coupler toward the moto far enough to disengage from th mating coupler.



1 Securing screws
2 Securing screws
3 Power plug
4 Grease fitting

Figure 147. Antenna blower detail.

(6) Remove the compressor motor.

(7) Loosen hose clamp (7) behind the compressor.

(8) Remove holddown bolt (3) behind the air intake pipe.

(9) Remove four compressor securing bolts (8) and remove the compressor. Two bolts (not shown) are at the other end of the compressor.

Note. Compressor grease fitting (9) is shown with the cap removed.

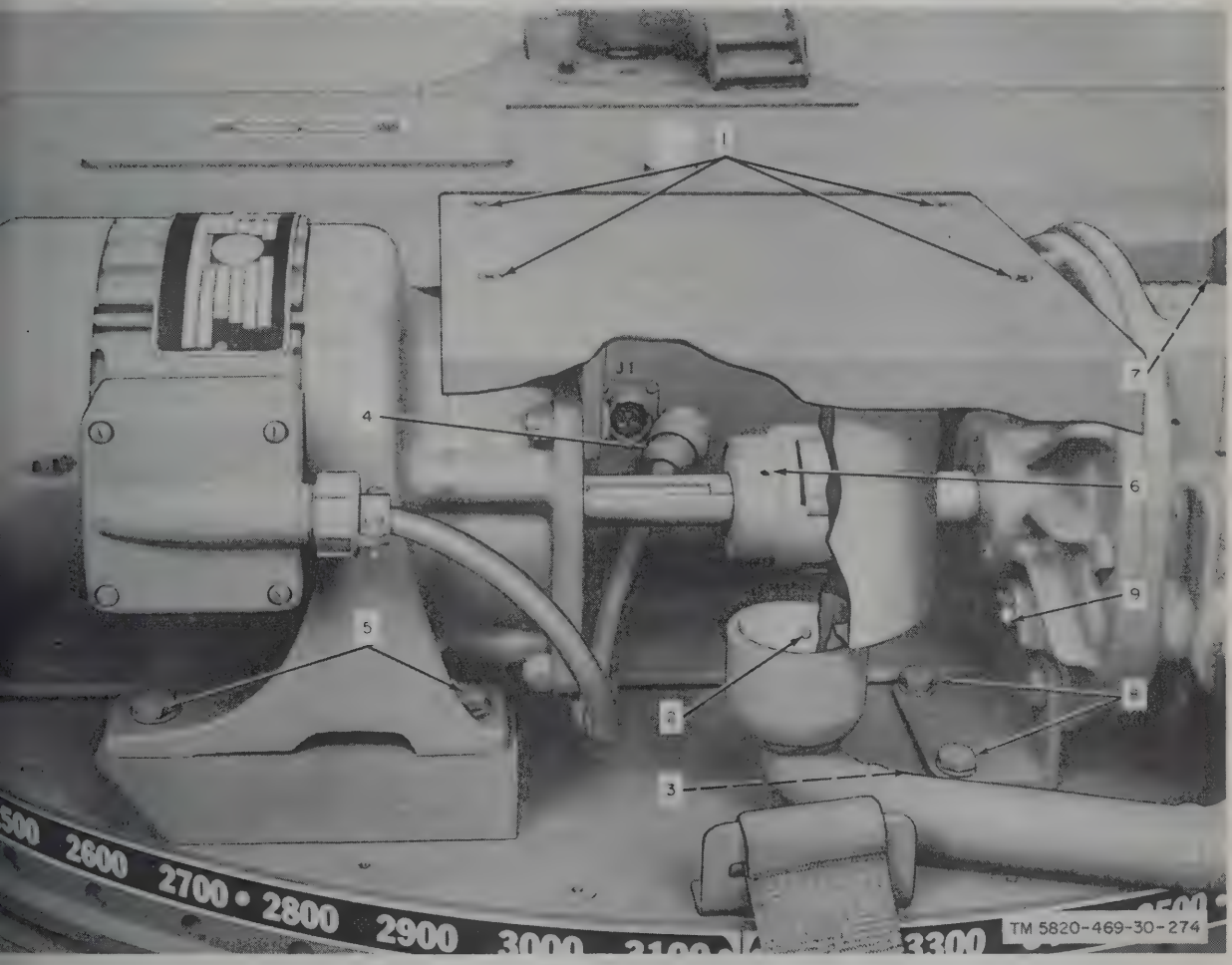
d. Compressor Replacement.

(1) Set the compressor in position and insert and tighten four compressor securing bolts (8).

(2) Install holddown bolt (3) behind the air intake pipe.

(3) Slide the hose in position and tighten hose clamp (7).

(4) Place the motor in position and insert and tighten four compressor motor securing bolts (5).



1 Flathead screws
2 Air filter case retaining screw
3 Holddown bolt
4 Power plug
5 Compressor motor securing bolts
6 Mating coupler setscrew
7 Hose clamp
8 Compressor securing bolts
9 Grease fitting

Figure 148. Antenna compressor detail.

(5) Slide the coupling to engage the mating coupling and tighten mating coupler setscrew (6).

(6) Insert power plug (4).

(7) Insert the air filter case and lock it in place by tightening air filter case retaining screw (2).

(8) Install the guard plate, using four flathead screws (1).

289. Control Panel

(fig. 141)

a. Control Panel Removal.

(1) Remove four screws on the right-hand side of the unit and swing the control panel out on its hinges.

(2) Remove HEADSET connector from J3.

(3) Remove the connectors from jacks J1 and J2 (located on rear panel).

(4) Remove the bolts securing the hinges to the rack channel, being careful to support the control panel.

(5) Remove the control panel for higher level maintentance.

b. Control Panel Replacement.

(1) Place the control panel in position o the rack, and secure the bolts on th hinges.

(2) Connect the connectors on jacks J and J2.

(3) Secure the four screws on the righ hand side of the panel.

(4) Connect the HEADSET connector t J3.

290. Teletypewriter Switch Panel and TH–5A/TG

(fig. 143)

Removal and replacement procedures for th teletypewriter switch panel and the TH–5A TG are outlined in paragraph 45 of TM 11 5820–469–20. To gain access to the teletyp writer switch panel, remove 14 screws to r move the top and rear covers. This exposes a internal components. Repair procedures for th TH–5A/TG are covered in TM 11–5805–246 35.

Section II. ADJUSTMENTS

291. Power Amplifier Control Panel

a. Test Connections. To perform adjustments on the power amplifier control panel, remove the control panel from the cabinet (para. 43*a*, TM 11–5820–469–20). Connect the pa control panel test cable extender (26, fig. 150) between J101 (fig. 32) on the control panel and the cable connector on the pa alarm and overload test set (fig. 150).

b. Filament Interlock Relay Adjustment.

(1) Connect the power cord on the test set case to a 115-volt 60-cps power source. Place the FILAMENT switch on the control panel to ON. Set the POWER switch on the pa alarm and overload test set to ON.

2) Turn the FILAMENT ADJUST MIN-MAX control fully counterclockwise. Turn R142 (fig. 32) fully counterclockwise.

(3) Connect an ME–26B/U between th two jacks across T102 on the pa alar and overload test set front panel. A just the FILAMENT ADJUST MI MAX control to indicate 72 volts (a on the meter.

(4) Turn R142 clockwise until the FIL MENT lamp just lights.

(5) Turn the FILAMENT ADJUST MI MAX control clockwise to indicate 7 volts ac on the meter, and then turn counterclockwise until the FIL MENT lamp is extinguished. Th meter reading should be not less tha 42 volts ac. Repeat the procedu given in (3) and (4) above if nece sary. Disconnect the test set and r place the power amplifier control pan in the cabinet.

c. Chopper Balance Adjustments (fig. 32).

(1) With the control panel installed in the cabinet and power removed, connect an ME–30B/U (set to measure approximately 10 millivolts) between test jack J103 and ground.

(2) Set the FILAMENT switch to ON, and adjust the power amplifier for normal output.

(3) Adjust chopper balance resistor R109 for a minimum meter indication.

(4) Repeat the procedure given in (1), (2), and (3) above, using test jack J102 and adjusting resistor R110.

d. Direct and Reflected Alarm Relay Adjustment.

(1) Remove the power amplifier control panel from the cabinet and connect it to the pa alarm and overload test set as directed in *a* above.

(2) Connect the power cord on the test fixture to a 115-volt, 60-cps source. Place the FILAMENT switch on the control panel to ON. Set the POWER switch on the test set to ON. Turn the FILAMENT ADJUST MIN-MAX control clockwise until the FILAMENT lamp lights. Allow the time delay relay 3 minutes to operate.

(3) Press the BEAM ON button on the control panel. Place the METER SELECTOR switch on the pa alarm and overload test set in the OUTPUT position. Adjust potentiometer R123 (fig. 32) on the control panel so that the ALARM lamp lights at 800 watts (as indicated on the INCIDENT scale of POWER OUT meter M102) when the INCIDENT control on the test set is adjusted to lower the incident power from a higher level through 800 watts.

(4) Adjust the INCIDENT control on the test set for an incident power reading of 1,000 watts on the POWER OUT meter.

(5) Set the METER SELECTOR switch on the pa alarm and overload test set to OUTPUT. Adjust R121 (fig. 32) on the control panel so that the ALARM lamp lights at 80 watts (as indicated on the REFLECTED scale of POWER OUT meter M102) when the reflected power reading is increased from a lower level through 80 watts by adjusting the REFLECTED control on the test set.

(6) Adjust R122 (fig. 32) on the control panel so that the BEAM lamp extinguishes at 100 watts (as indicated on the REFLECTED scale of POWER OUT meter M102) when the reflected power reading is increased through 100 watts by adjusting the REFLECTED control on the test set.

292. Klystron Tuning Adjustments

The procedures listed below should be followed when a new klystron is installed or when tuning difficulty is observed. If these adjustments do not provide normal operation, refer to paragraph 279*a* for klystron replacement procedures.

a. Initial Adjustments.

(1) Set the FILAMENT ADJUST control to obtain a 6.5-volt indication on FILAMENT VOLTAGE meter M103. After approximately 3 minutes, the TIME DELAY indicator comes on.

(2) Place the TUNE-OPERATE switch in the TUNE position to temporarily disable the warning buzzer. Place the input power REFLECTED-INCIDENT switch in the REFLECTED position, and adjust DRIVE LEVEL control AT201 for an indication of approximately 40 milliwatts on the POWER IN meter. Set BEAM VOLTAGE switch S302 to position 2.

Caution: **Low beam voltage is recommended during the first steps of tuning to reduce the possibility of klystron damage. It is possible for the first three cavities to be correctly adjusted and still not receive an incident power output reading if the fourth cavity has not been turned. Under these conditions there is virtually**

no rf load on the third cavity to absorb the power, and the high voltage may cause dangerously high temperatures in the third cavity *This may permanently damage the klystron tube.* Once an INCIDENT power output indication has been obtained, the beam voltage may be increased if desired.

b. Klystron Tuning, Synchronous or High Gain Adjustment.

(1) Press the BEAM ON pushbutton. Adjust the FIRST CAVITY control to obtain a dip on the POWER IN meter. The approximate counter position may be determined from the graph on the front of the klystron drawer. Set all remaining CAVITY controls to the same counter reading.

(2) Place the POWER IN meter selector switch to the DIRECT position and reduce the drive power to indicate between 1 to 3 milliwatts. This is done to permit synchronous tuning.

(3) Adjust cavities 4, 2, and 3, in that order, to obtain the maximum INCIDENT power indication on POWER OUT meter M102. Only one indication of resonance should be obtained on each cavity control. If there is difficulty locating a response, temporarily increase the drive to 20 milliwatts or more.

***Caution:* Never permit the output power to rise above 300 watts until the drive has again been reduced to less than 3 milliwatts. Failure to observe this precaution may result in sudden destruction of the tube if the third cavity is accidently tuned to the dip instead of the upper response. Note the tuning response of the third cavity for varying amounts of drive power.**

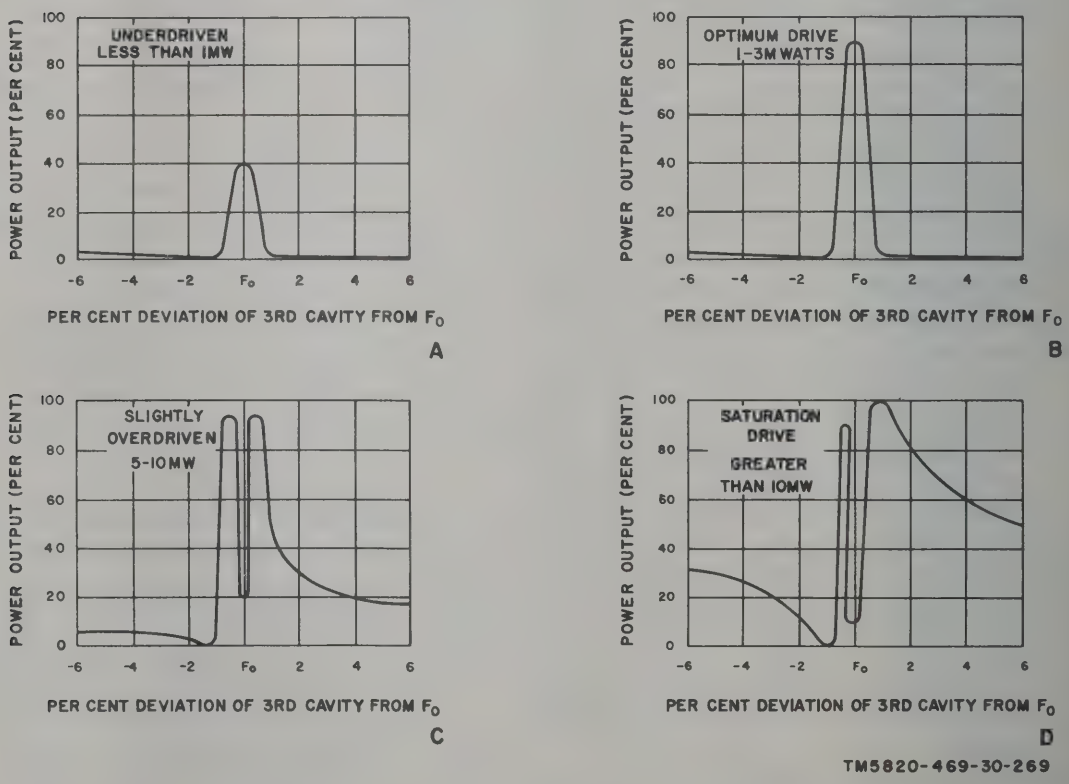


Figure 149. Klystron tuning curves.

c. Klystron Adjustment, Maximum Effi-ency. The power amplifier may be operated ntinuously with low input power if desired, , if necessary, because of low exciter output. should be possible to obtain rated power tput (1 kilowatt (kw)) with as little as 3 lliwatts input power. However, to obtain eater output stability and higher efficiency ecommended operation), continue the tuning ocedure as indicated below.

(1) Increase the position of the THIRD CAVITY control by approximately 25 counter digits. Raise the drive level to obtain a 40-milliwatt indication.

(2) Slowly lower the THIRD CAVITY control for a maximum INCIDENT POWER OUTPUT indication. With saturation drive (D, fig. 148), the new THIRD CAVITY control adjustment giving maximum power output will be approximately five digits higher than when synchronously tuned. The curve showing output with saturation drive also illustrates why the drive level must not be increased when the klystron has been synchronously tuned. The output power drops sharply and klystron damage can occur suddenly. When adjusting for maximum efficiency operation, first increase the position of the THIRD CAVITY control, and then increase the drive and retune.

(3) Adjust the BEAM VOLTAGE tap switch, as required, to obtain the rated 1-kilowatt output. After a few minutes operation, slightly readjust the FOURTH CAVITY control for maximum output power as indicated by the INCIDENT scale of the POWER OUT meter.

(4) Place the TUNE-OPERATE switch at OPERATE. Any significant change in direct or reflected output power levels operates an alarm and warns the operator. A buzzer sounds and ALARM indicator DS106 illuminates if the incident power output falls below 800 watts, or if the reflected power output rises above 80 watts.

Caution: **During training or other nontactical exercises, an effort should be made to operate the klystron near the midband or around 4.7 kmc. Klystron tuner fatigue is greatly accelerated when the cavities are adjusted to within 100 digits of either the high- or low-frequency end of the band. When operation at extreme ends of the band becomes necessary, these adjustments should be made with as little tuning as possible. Regardless of the frequency, once adjusted, actual operation of the tube should cause no difficulty.**

d. Klystron Cavity Tuning Indicator Adjustment. When the klystron has been synchonously tuned (*b* above), all four cavity tuning indicators should show the same channel setting. If the tuning indicators do not show the same channel setting, use the following procedure:

(1) Tune the four cavities to a frequency of 4,697.8 mc (channel 761).

(2) All channel window indicators should show 240.

(3) If any indicator does not show 240, proceed as follows:
   (*a*) Turn off all pa power.
   (*b*) Loosen the setscrew on the tuning indicator coupler (fig. 44) to the indicator mechanism.
   (*c*) Hand-turn the window mechanism shaft until the indicator shows exactly 240.
   (*d*) Tighten setscrew and return power.

Note. This procedure will place all indicators correctly at the midrange. The two tuning extremes will automaticall track correctly.

293. Transmit Converter Meter Calibration

a. Meter Position F. The oscillator and multiplier units must first be tuned to a channel near 5 kmc (refer to TM 11–5820–469–10 for tuning instructions). Measure the output power available from the multiplier unit. The power at this frequency will be less than elsewhere over the band.

(1) Remove the transmit converter from the rack (para. 278) and place it on a workbench.

(2) Connect 110-volt, 60-cps power to TB1 (fig. 47) of the transmit converter.

(3) Insert a crystal corresponding to channel 927 (17, fig. 150) in socket XY1 (fig. 51) of the oscillator unit.

(4) Place switch S1 on the oscillator unit at INT.

(5) Place the POWER switch at ON.

(6) Tune the oscillator and multiplier units to channel 927 as directed in TM 11–5820–469–10.

(7) Disconnect plug P11 (fig. 46) from jack J1 on the varactor multiplier.

(8) Connect a 20 db attenuator (3, fig. 150), an N female to TNC female adapter (10, fig. 150), and Power Meter AN/USM–96A (in that order) to P11.

(9) Adjust LEVEL ADJUST control R32 on the transmit converter to obtain 400-milliwatt output power on the AN/USM–96A.

(10) With the meter switch in position F, adjust potentiometer R33 (fig. 46) for an indication of 70 microamperes on the front panel meter. Lock R33.

(11) Turn power off.

(12) Remove test equipment and reconnect P11 to J1 of the varactor multiplier.

(13) Place S1 on the oscillator unit at EXT.

b. Meter Position H. The oscillator, multiplier, and varactor multiplier units must all first be tuned to a channel near 5 kmc. (Refer to TM 11–5820–469–10 for tuning procedures.) Measure the power output available from the varactor multiplier output at T2 (fig. 47).

(1) Set up the equipment as directed in *a* (1) through (5) above.

(2) Tune the oscillator unit, multiplier unit, and varactor multiplier to channel 927 as directed in TM 11–5820–469–10.

(3) Disconnect plug P13 from rf signal detector CR5 (fig. 47).

(4) Connect a 10-db coaxial attenuator (1, fig. 150), an N female to TNC female adapter (10, fig. 150), a Power Meter AN/USM–96A to P

(5) Adjust LEVEL ADJUST control R to obtain 20-milliwatt (or the ma mum obtainable at this frequen output power.

(6) With the meter switch in position adjust R37 (fig. 46) for an indicat of 50 microamperes on the pa meter. Lock R37.

c. J. OUTPUT Meter Position. The compl transmit converter must be tuned in the nor manner.

(1) Set up the equipment as directed *a*(1) through (5) above.

(2) Apply a 70-mc signal at J5. Follow procedure given in 229*b*(1) and (

(3) Connect a 20-db shf attenuator (5, 150), a TNC male to N female ad ter (9, fig. 150), and Radio Freque Power Test Set AN/USM–96A chassis jack J7 (fig. 47).

(4) Adjust LEVEL ADJUST control R to obtain an output of 500 milliwa at J7 (as indicated on the AN/US 96A).

(5) With the meter function selec switch at J. OUTPUT, adjust R (fig. 46) for an indication of microamperes. Lock R36.

294. Traveling Wave Tube and Power Supply

a. Helix Overload Relay. Potentiometer R (fig. 47) controls the current through h overload relay K2 (fig. 46). To adjust R2

(1) Turn off power to the transmit c verter.

(2) Disconnect XV9 (fig. 47) from tra ing wave tube (twt) V9 and conn socket XV9 to the cable connector the traveling wave tube power sup test set (test facilities kit, fig. 150

(3) Connect an adjustable dc power s ply between the HELIX and gro jacks of the twt test set and adj the output of the power supply 25 volts dc.

(4) Set up a TS–352A/U as a milliammeter and connect it between the negative side of the 25-volt supply and ground.

(5) Adjust R26 (fig. 47) on the transmit converter so that relay K2 operates at a current of 2.5 ma. (An ohmmeter can be connected to the normally open contacts of K2 (fig. 46) for a convenient indication of contact closure.)

(6) If an adjustable dc power supply is not available, a 45-volt dc dry battery in series with a 50,000 potentiometer may be used to provide the 25-volt dc voltage. When this method is used, the 50,000-ohm potentiometer and R26 may interact. The desired setting is such that the voltmeter (connected across the 25-volt source) indicates 25 volts and the milliammeter indicates 2.5 ma just as relay K2 operates.

b. Traveling Wave Tube Power Supply Adjustments. These adjustments will differ for ch traveling wave tube and must be perrmed very carefully. The transmit converter assis must be removed from the shelter bere making these adjustments. An unmodued 70-mc input signal is required at J5. llow the procedure given in paragraph 229*b*) and (2).

Warnng: **Follow the traveling wave tube nch cooling requirements and the high-volte safety considerations described in paraaphs 225 and 230.**

(1) Disconnect XV9 (fig. 47) from the traveling wave tube and connect XV9 to the traveling wave tube power supply test set (fig. 150).

(2) Apply 115-volt, 60-cps power to the transmit converter at terminals 1 and 2 of TB1.

(3) Set R11 (fig. 47) to provide an indication of 150 volts (this corresponds to 1,500 volts dc applied to the cathode of the traveling wave tube) at the CATHODE jack on the test set. This should occur at approximately the midposition of R11. Remove the test set and reconnect the traveling wave tube.

(4) Set R25 (fig. 46) fully ccw. Set the meter function selector switch to HELIX. Tune the transmit converter to a frequency near 5 kmc. Refer to paragraph 293*b* and complete the tuning procedure in the H position of the meter function selector switch (varactor multiplier output). Reduce or remove drive by turning LEVEL ADJUST control R32 fully counterclockwise or by removing B+ fuse F2.

(5) Set the meter function selector switch to HELIX and slowly advance R25 cw and adjust for a minimum indication on the panel meter. HELIX current will increase as R25 is turned cw, fall to a low value, and then rise again. It is this low value that is desired.

(6) Advance LEVEL ADJUST control R32 (or replace fuse F2 if it was removed) for a midscale meter indication in the H position of the meter function selector switch.

(7) Set the front panel meter switch to J. OUTPUT. Adjust R11 for a maximum indication. Control J on the tunable filter must also be adjusted for maximum output. Initially, it can be preset by referring to the channel-frequency tuning chart.

(8) Connect the AN/USM–96 to J7 (fig. 47) as directed in paragraph 293*c*(3). If the output power at J7 is between 500 milliwatts and 1 watt (R32 fully clockwise at 5 kms), this completes the adjustment. If not, continue with (9) below.

(9) Reduce or remove the drive. Set the meter function selector switch to HELIX. Adjust R25 to relocate the dip. Turn this control clockwise as necessary to obtain from 0.5 to 5 microamperes above the minimum (as indicated on the panel meter). This action increases the available power. Rotate R32 clockwise and again check the power output.

(10) Set the meter function selector switch to COLLECTOR. An indication between 30 and 55 is normal. The indication should *never* be allowed to exceed 80. If this current is too high, it will later cause the helix current to increase and operate overload relay K2, thereby disabling the power supply. Once adjusted, traveling wave tubes tend to draw more current when first turned on than during normal operation. If difficulty is encountered in getting sufficient power consistent with low collector and helix currents, follow the procedure given in (11) below.

(11) As in (9) above, relocate the dip and then rotate both controls clockwise together in very small increments. First increase R25 (fig. 46), and then R11 (fig. 47). Monitor both collector current and output power simultaneously. Use of this method should satisfy both the conditions of sufficient power and acceptable collector current. If not, the traveling wave tube may be faulty and another should be selected.

(12) During emergency conditions, the power amplifier can be operated at rated power with from 1–3 milliwatts direct drive as indicated on the POWER IN meter. Although there is no sacrifice in signal reliability, when operated with low drive, the power output becomes more sensitive to small changes in drive level and may require more frequent adjustment.

295. Multiplexer Clipping Level Adjustment (R2)

a. Preliminary. Follow the procedure given in paragraph 267*b*(1) through (5). If this test indicates that CLIPPING LEVEL ADJUST control R2 must be reset, use the procedure given below.

b. Procedure.

(1) Connect the multiplexer test cable and termination adapter (31, fig. 20*a*) to line voice jack J10 (fig. 130). Conne Signal Generator SG–71/FCC (ba anced output) to pins A and B of th adapter.

(2) Adjust the SG–71/FCC output fr 2,000 cps. Turn R2 (fig. 129) ful cw and set the input level to —2 dbm as measured at J1 (fig. 130 using the ME–30B/U.

(3) Terminate output connector J5 wi the 287-ohm BNC resistive termin tion (20, fig. 150). Set voice inp level adjust control R29 for an ind cation of —20 dbm at J6, using th ME–30B/U.

Note. The simultaneous use of two M 30B/U's, if available, makes it unnecessa to transfer the meter lead back and for between J1 and J6 as these measuremen and adjustments are made.

(4) Advance the generator input sign until the output level at J6 is 1 d lower than the input level at J1. No the output level.

(5) Adjust the input level to —5 dbm. S R2 to obtain the same output level that noted in (4) above.

(6) This completes the adjustment of R The output level should now rema within 2.5 db as the input level varied from 0 to +10 dbm.

296. Modulator-Multiplier Adjustments

a. Order-Wire Modulator Balance.

(1) Remove the order-wire input signal disconnecting the cable from orde wire input jack J8 on the rear pan (fig. 24, TM 11–5820–469–20).

Note. When the AN/TRC–80 is used part of the Pershing Weapon Systems, t multiplex input signal is normally appl through OW INPUT jack J8.

(2) Connect an ME–26/U at test jack (fig. 67 (part 1)) and measure t low-voltage ac.

(3) Adjust OW BAL control R20 (f 67 (part 1)) for minimum meter in cation. Lock R20.

(4) Depress CARRIER switch pushbu ton. Meter indication should drop zero.

(5) Reconnect cable to jack J8.

b. Multiplex Modulation Balance.

(1) Remove the order-wire input signal by disconnecting the cable from order-wire input jack J8 on the rear panel.

(2) Connect an ME–26/U to measure ac at test jack J2 (fig. 67 (part 2)).

(3) Adjust MUX BAL control R42 (fig. 67 (part 2)) for minimum meter indication. Lock R42.

(4) Depress the CARRIER SWITCH pushbutton. The meter indication should drop to zero.

(5) Reconnect cable to jack J8.

c. Order-Wire Deviation.

(1) On the control panel, press the TEST SIGNAL pushbutton.

(2) Place monitor selector switch S2 in position B and adjust the control panel TEST SIGNAL LEVEL control for SET POINT on the monitor meter.

(3) Set monitor selector switch S2 to position A.

(4) Adjust OW DEV control R17 (fig. 67 (part 1)) for SET POINT indication on the monitor meter. Lock R17.

(5) Remove the test signal by pressing the control panel TEST SIGNAL pushbutton.

297. Monitor Adjustments

a. Deviation Set Point Calibration.

(1) Disconnect P1 from J8 (fig. 22, TM 11–5820–469–20) and connect fm Signal Generator AN/URM–48 to jack J8, using a BNC tee adapter (8, fig. 150). Connect Modulation Meter ME–57/U to the other side of the tee.

(2) Set the AN/URM–48 to 70 mc and adjust the RF input level for approximately 0.2 volt. Frequency-modulate the 70-mc carrier at 1,000 cps to produce a 9-kc peak deviation, using the self-contained meter on the signal generator. Verify this deviation by use of the ME–57/U.

Note. If there is difficulty obtaining 0.2 volt, remove the ME–57/U after setting the deviation and before checking the monitor.

(3) Set attenuation selector switch S1 to position A. Set monitor line selector switch S2 to position A.

(4) The monitor now functions as an fm deviation meter where a SET POINT indication on the front panel meter corresponds to a 9-kc peak deviation. Adjust deviation set point adjust control R71 (fig. 135) to obtain this indication.

(5) Remove the adapter from J8 and connect plug P1 to J8.

b. Line Monitor Set Point Adjust.

(1) Connect Signal Generator SG–71/FCC (unbalanced output) to monitor line voice input jack J1, using a BNC tee adapter (8, fig. 150). Connect an ME–30B/U to the free end of this adapter.

(2) Set the generator to 1,000 cps, and carefully adjust the level to 370 millivolts as measured by the ME–30B/U.

(3) Turn monitor line selector switch S2 to position B (S1 is no longer in the circuit). Meter M1 should indicate SET POINT. Adjust test tone voltage level set point adjust control R70 (fig. 135), if necessary, to obtain this indication.

(4) After completing the procedure given in (3) above, the remaining monitor line inputs can be tested as shown in the chart below. Each of the input voltages listed below should provide a SET POINT indication once control R70 has been properly adjusted.

Input jack	S2 meter position	Input voltage (millivolts)
J2	C	239
J3	D	194
J4	E	375
J5	F	256
J6	G	171
J7	H	123
J9	J	52

298. IF Amplifier Combiner Adjustments

a. General. The combiner balance may be adjusted with the receiver installed in the shelter, but the IF chassis must be swung out to gain access to output jack J4 (fig. 123). A very low-

level ac voltage measurement is required. If voltmeter ground loops within the shelter cause high noise readings (greater than —25 dbm), move the IF amplifier and its power supply to the test van before making this adjustment. The deviation monitor, normally used to monitor the voltage at J4 (S2 position D), is not sufficiently sensitive for use in making this adjustment. The combiner voltage and threshold adjustments, which follow, are best performed in the sequence given with the receiver installed in the shelter.

Note. Refer to figure 190 for the simplified circuit of the intermodule combiner control voltage routing.

b. Combiner Balance Adjustment R27.

(1) Connect vacuum tube voltmeter ME–30B/U to audio output chassis connector J4. Terminate this line with 619-ohm BNC–GR resistive termination (12 and 21 fig. 150) connected together, at the voltmeter.

(2) Turn COMBINER THRESHOLD ADJUST control R28 (fig. 97) fully counterclockwise. This keeps the combiner tubes biased on at all times. Remove discriminator tube V3 (fig. 21, TM 11–5820–469–20) from its socket to remove all receiver background noise. Adjust the RCVR GAIN control to obtain an indication of 6 on the IF amplifier tuning meter.

(3) Depress COMBINER BAL TEST pushbutton switch S1 on the bandwidth module (fig. 97) and simultaneously adjust COMBINER BALANCE control R27 (fig. 117) on the discriminator-combiner module for a sharp null reading on the voltmeter. The null should not exceed —28 dbm. Lock R27.

c. Combiner Voltage Adjustment R47. (fig. 97).

(1) Connect an ME–26B/U to J3 on the bandwidth module and measure the combiner control output voltage.

(2) Set S1 on the 8-mc IF amplifier No. 2 to RCVR GAIN. Set RCVR GAIN control R4 to obtain a reading of 10 on the meter. This simulates an inc ing signal just over the thresh point.

(3) Adjust COMB. VOLTAGE SETTI control R47 to obtain +21 volts d J3. Lock R47.

d. Combiner Threshold Adjust R28 (fig. 9

(1) Use meter ME–26B/U to monitor dc voltage at J3 as above.

(2) Set S1 on 8-mc IF amplifier No. 2 RCVR GAIN and carefully set RC GAIN control R4 to 6 on the me COMBINER THRESHOLD ADJU control R28 should be fully coun clockwise, and the voltage will i cate approximately 20 volts dc at A loud rushing noise will be heard the loudspeaker.

(3) Slowly advance the COMBIN THRESHOLD ADJUST control clo wise until the dc voltage at J3 s denly drops to approximately 7.5 v dc. The receiver noise will sudde cease.

(4) Verify that the proper adjustment been made by slowly advancing RC GAIN control R4 until the volt jumps back up to about 21 volts and the loud rushing noise reappe Advancing the receiver gain con in this manner simulates a low-l input signal just above the thresh point. The combiner should be bia off when the RCVR GAIN contro set to indicate 6 on the meter, should turn back or when the m indicates from 8–10. If these co tions are not met, repeat the proc ure as necessary.

(5) In effect, the COMBINER THR HOLD ADJUST control squelches receiver in the absence of incom signals, but permits it to turn quickly with a low-level input sig For best results, this adjustm should be made with the receiver stalled in the shelter as it would b normal operation.

. Response to Near Threshold Signal Levels
(fig. 71)

his test should be performed when the sig- to be received are near threshold level or naccurate tuning of the preselector is sus- ted. This adjustment can be performed with receiver installed in the shelter.

. Remove cable connector P12 from connec- J1 on waveguide tune up signal injector as- bly A10.

. Connect a TNC right angle adapter (6, fig.) to J1.

c. Attach the 10-db coaxial shf attenuator (4, fig. 150) to the TNC adapter, and connect P12 to the free end of the attenuator.

d. Turn TUN DET METER ADJUST control F12 fully clockwise.

e. Depress TUNE-UP SIGNAL switch S2 and adjust the preselector to obtain peak meter indication (switch S1 at J–TUN. DET).

f. The meter indication will be much less than half-scale, but any increase in meter deflection when the TUNE-UP SIGNAL button is pressed indicates that the receiver will respond properly to very weak signal levels.

pg 26

200 v DC 200 v Power supply
6.3 v AC multiplier A3
4 6442 tubes
90-102 in
6 - 6542 1082 - 1232 out
1 - 6384

varactor ~~tripler~~ X4
input 1082.7 - 1232.1 mhz
out 4.333 - 4928 mhz out

RF detector CR4

Bal mod

tuneable filter 4.4-5 Kmhz

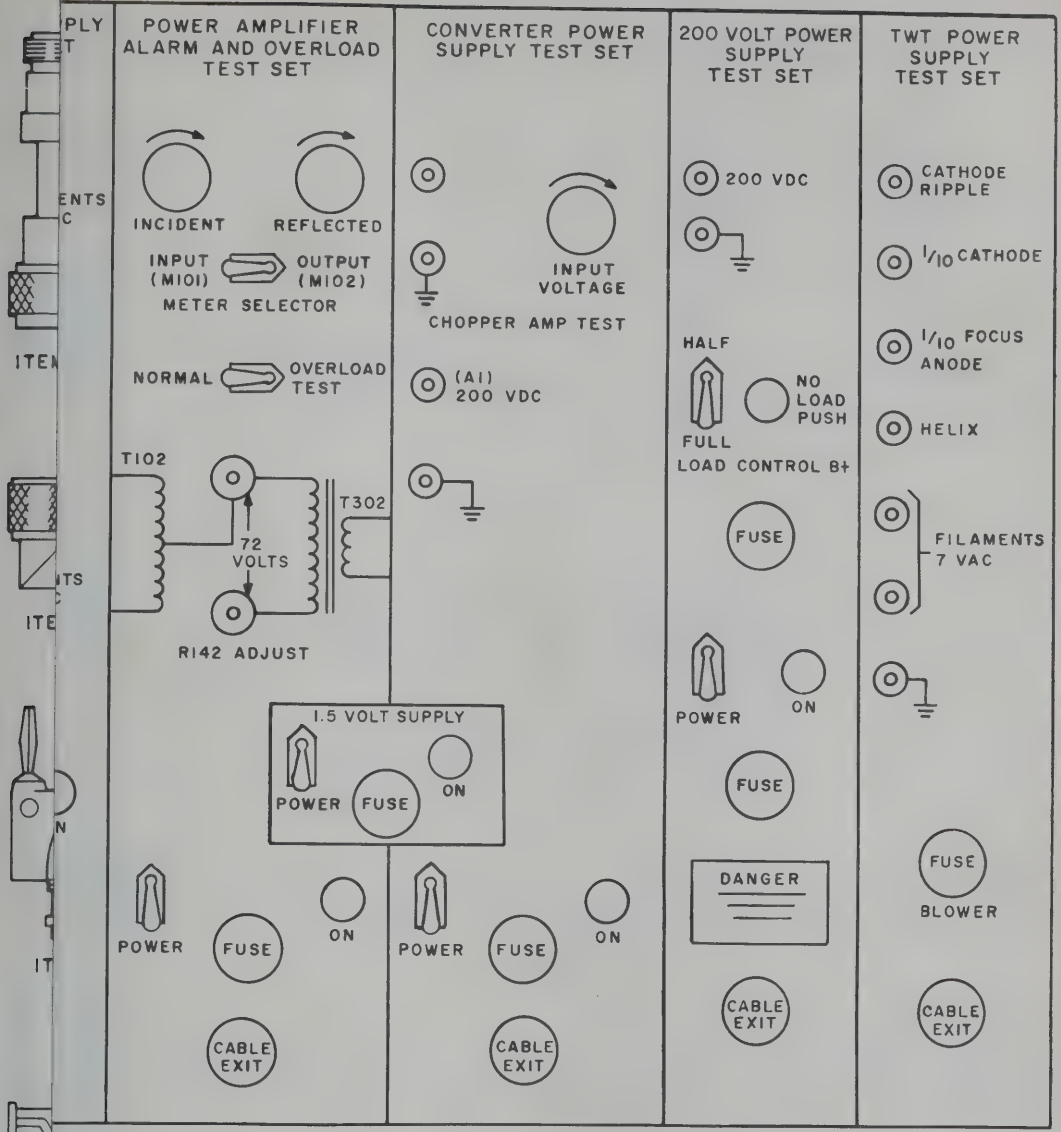
RF detector CR5

to Power Amp

TWT HA35N

LP filter 4.4-5 khmz

pg 315 4.4 - 5 Kmhz



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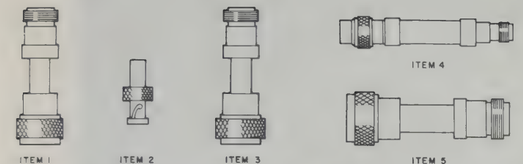
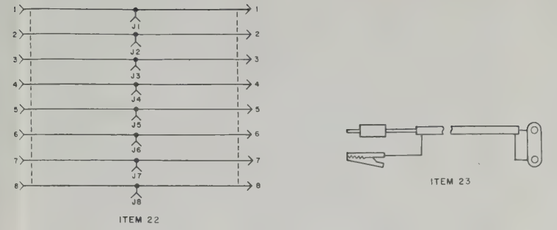
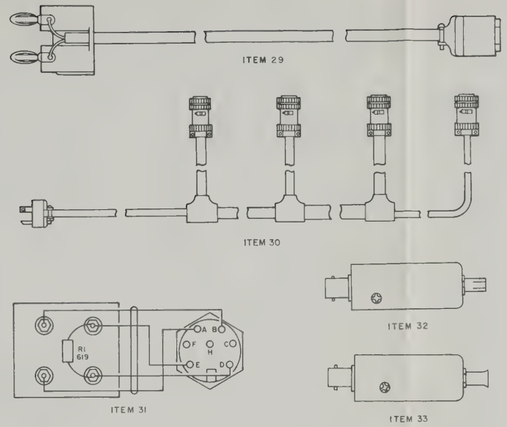






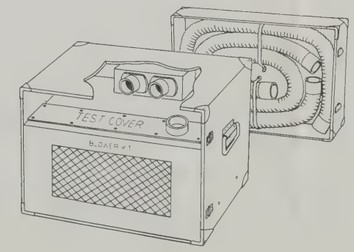
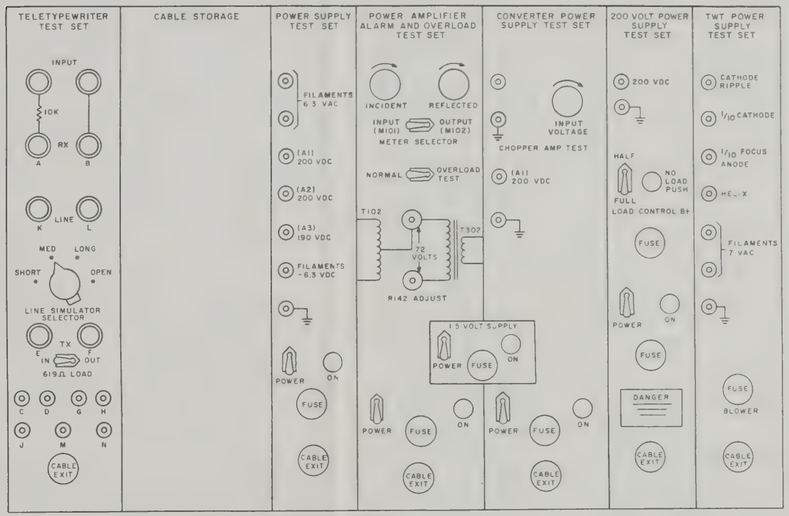


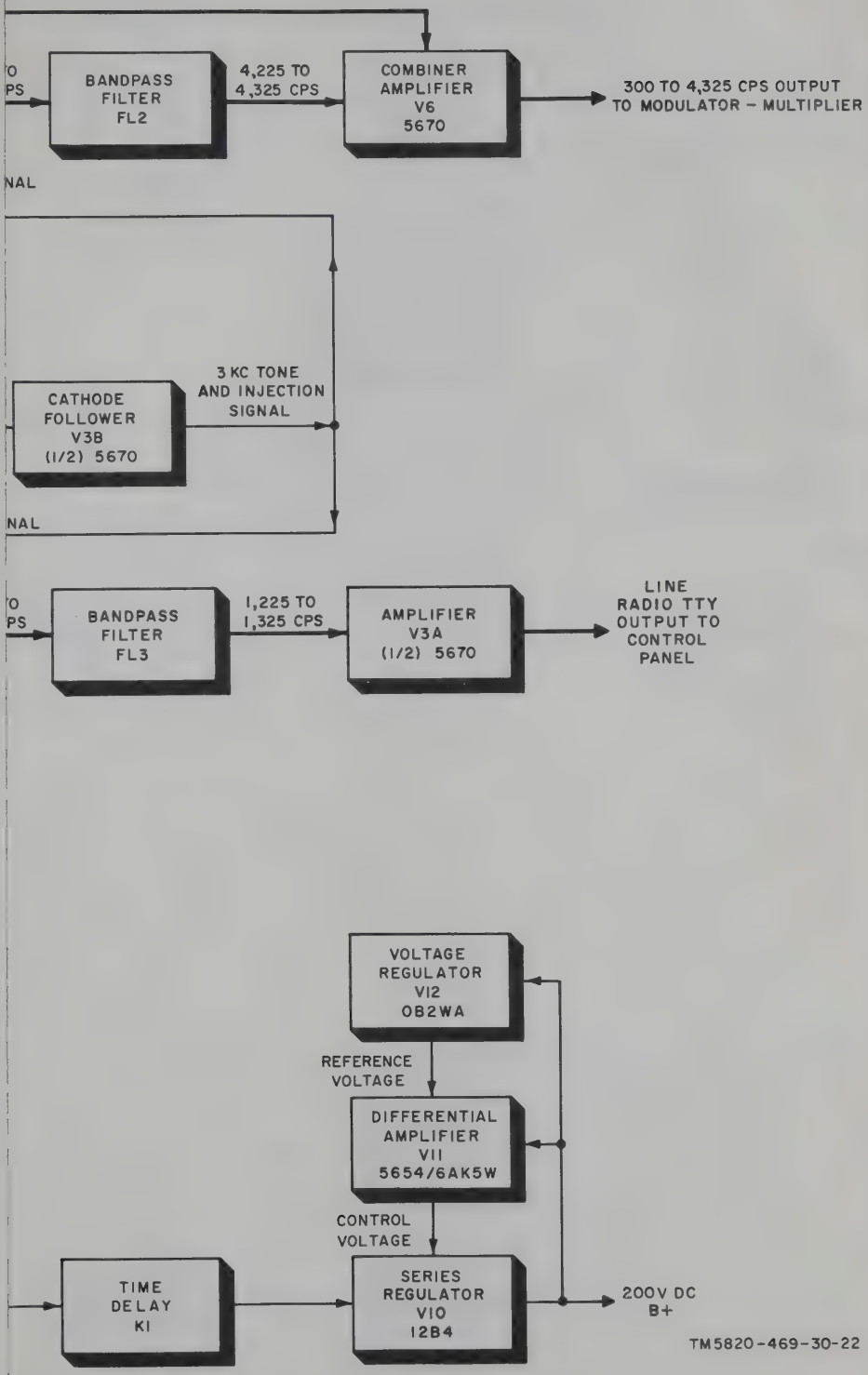
Figure 150. Direct support test facility kit, test adapters, connectors, and test circuits.



NOTES

1. ITEM 1 THROUGH 33 ARE CONTAINED WITHIN A CABLE KIT CARRYING CASE THAT IS PART OF THE TEST FACILITIES KIT.
2. THE TEST SETS ARE CONTAINED WITHIN A CARRYING CASE. THE AC POWER CORD SHOULD BE CONNECTED TO A 115-VOLT 60-CPS POWER SOURCE.

TM5820-469-30-87


TO PS
BANDPASS FILTER FL2
4,225 TO 4,325 CPS
COMBINER AMPLIFIER V6 5670
300 TO 4,325 CPS OUTPUT TO MODULATOR – MULTIPLIER
NAL
CATHODE FOLLOWER V3B (1/2) 5670
3 KC TONE AND INJECTION SIGNAL
NAL
TO PS
BANDPASS FILTER FL3
1,225 TO 1,325 CPS
AMPLIFIER V3A (1/2) 5670
LINE RADIO TTY OUTPUT TO CONTROL PANEL
VOLTAGE REGULATOR VI2 OB2WA
REFERENCE VOLTAGE
DIFFERENTIAL AMPLIFIER VII 5654/6AK5W
CONTROL VOLTAGE
TIME DELAY KI
SERIES REGULATOR VIO 12B4
200V DC B+
TM5820-469-30-22

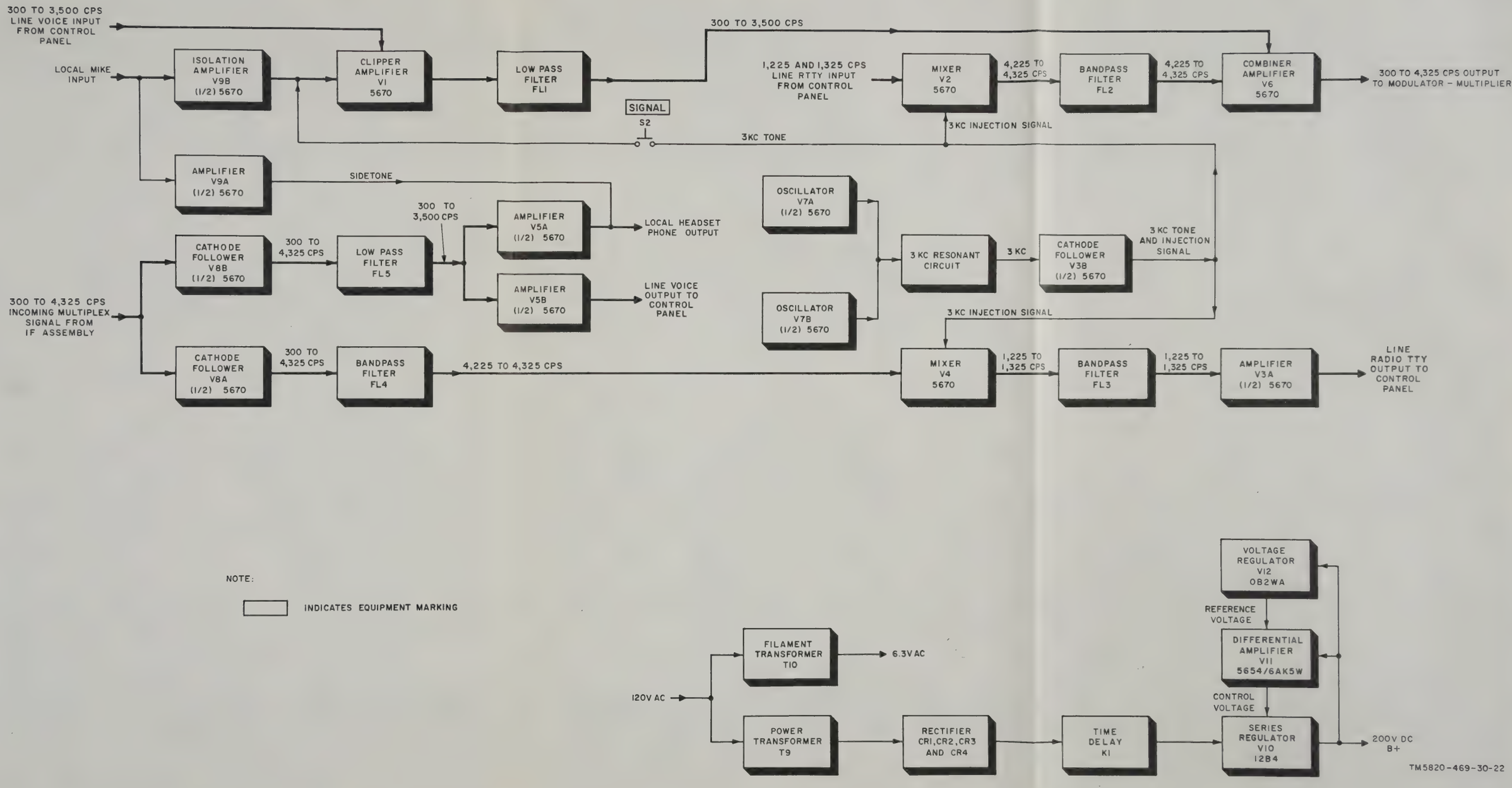
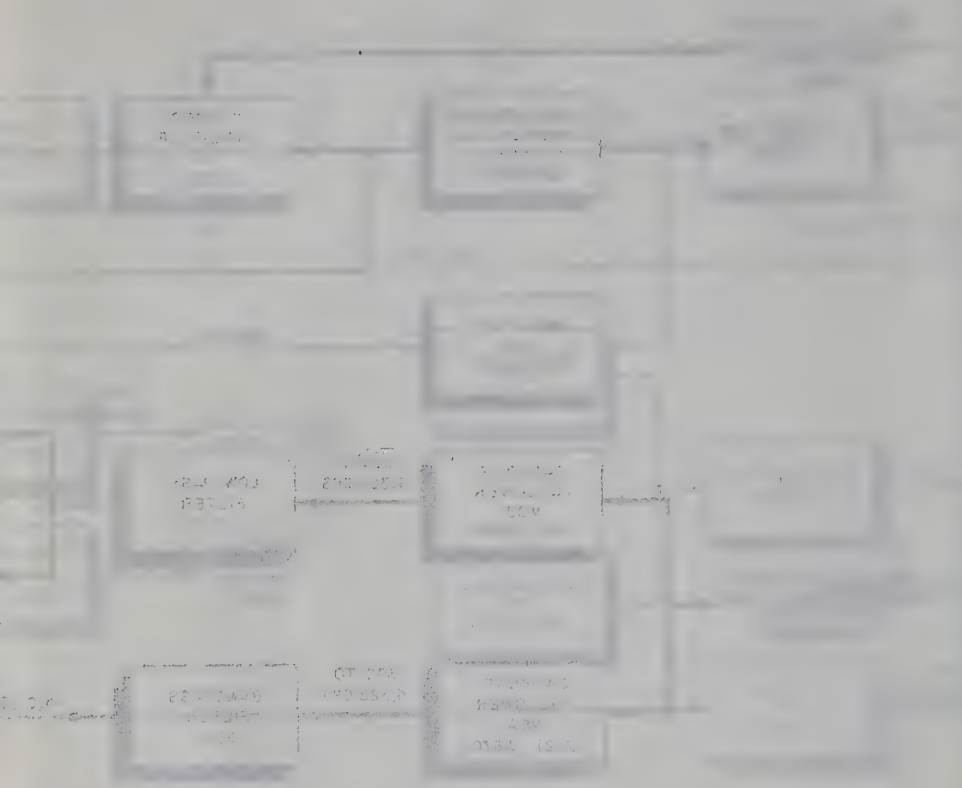
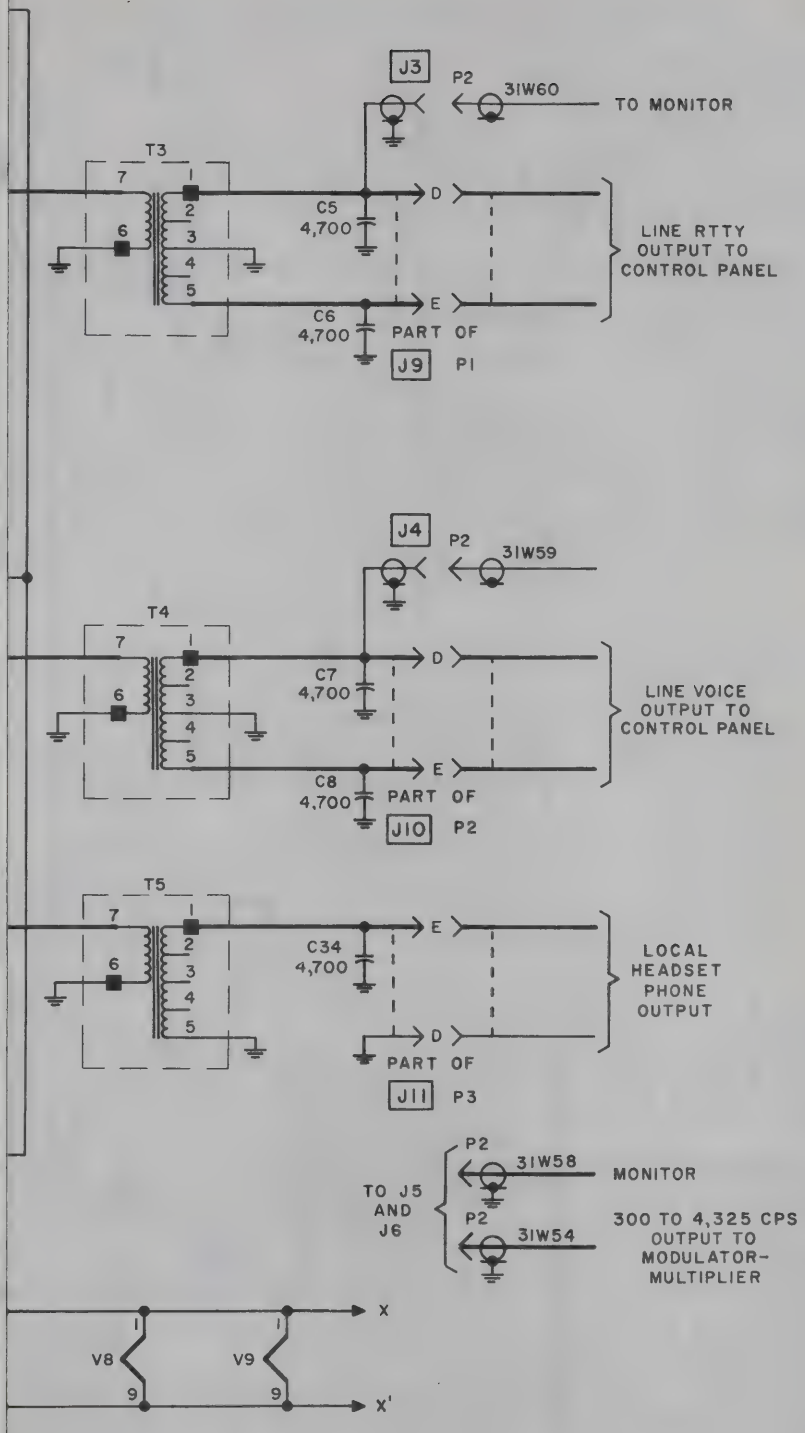


Figure 151. Demultiplexer-Multiplexer TD-550/TRC-80, block diagram.





TM5820-469-30-4

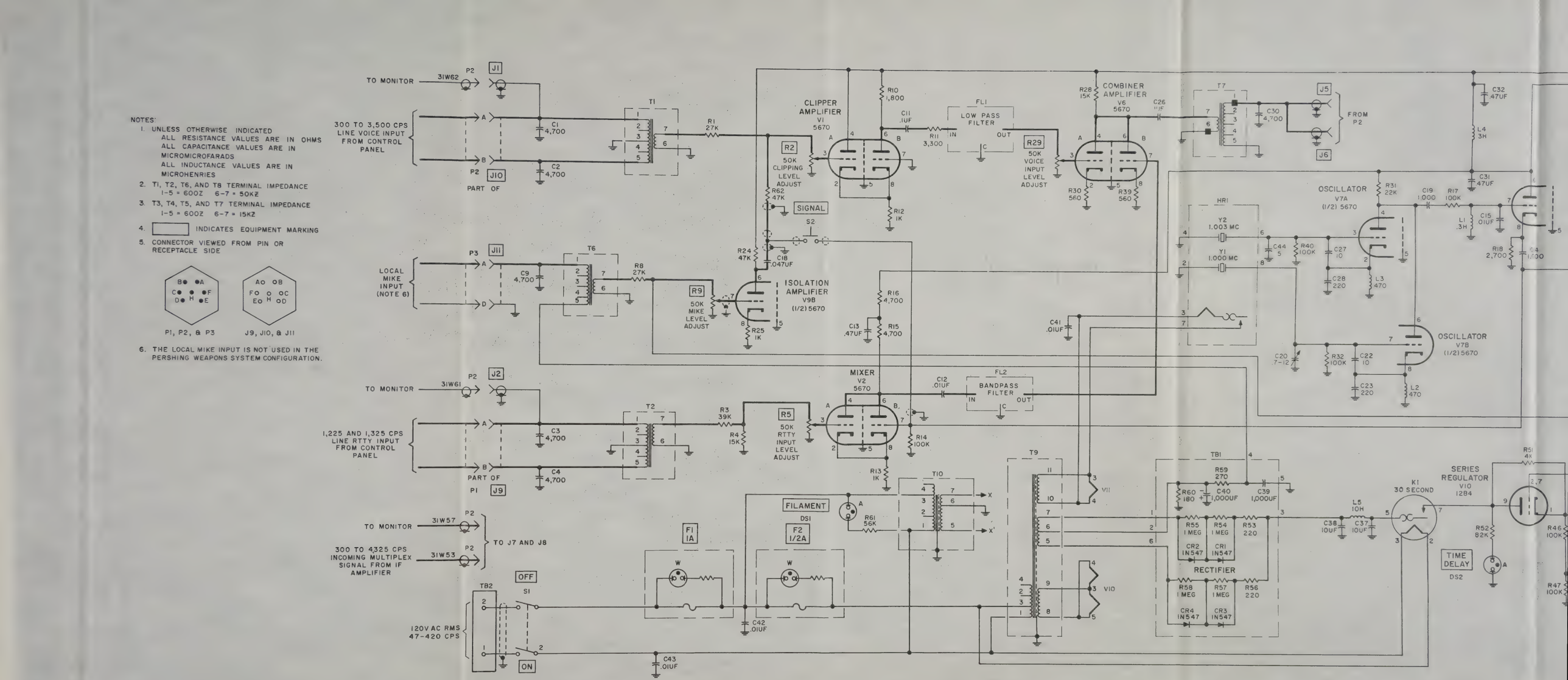

NOTES:
1. UNLESS OTHERWISE INDICATED ALL RESISTANCE VALUES ARE IN OHMS ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. T1, T2, T6, AND T8 TERMINAL IMPEDANCE 1-5 = 600Z 6-7 = 50KZ
3. T3, T4, T5, AND T7 TERMINAL IMPEDANCE 1-5 = 600Z 6-7 = 15KZ
4. INDICATES EQUIPMENT MARKING
5. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE
P1, P2, & P3
J9, J10, & J11
6. THE LOCAL MIKE INPUT IS NOT USED IN THE PERSHING WEAPONS SYSTEM CONFIGURATION.
TO MONITOR
31W62
300 TO 3,500 CPS LINE VOICE INPUT FROM CONTROL PANEL
PART OF
LOCAL MIKE INPUT (NOTE 6)
TO MONITOR
31W61
1,225 AND 1,325 CPS LINE RTTY INPUT FROM CONTROL PANEL
PART OF
TO MONITOR
31W57
300 TO 4,325 CPS INCOMING MULTIPLEX SIGNAL FROM IF AMPLIFIER
31W53
TO J7 AND J8
120V AC RMS 47-420 CPS
OFF
ON
CLIPPER AMPLIFIER V1 5670
50K CLIPPING LEVEL ADJUST
SIGNAL
ISOLATION AMPLIFIER V9B (1/2) 5670
50K MIKE LEVEL ADJUST
MIXER V2 5670
50K RTTY INPUT LEVEL ADJUST
LOW PASS FILTER
BANDPASS FILTER
COMBINER AMPLIFIER V6 5670
50K VOICE INPUT LEVEL ADJUST
FROM P2
OSCILLATOR V7A (1/2) 5670
OSCILLATOR V7B (1/2) 5670
Y1 1.000 MC
Y2 1.003 MC
FILAMENT
DS1
F1 1A
F2 1/2A
RECTIFIER
SERIES REGULATOR V10 1284
K1 30 SECOND
TIME DELAY
DS2

Figure 152. Demultiplexer-Multiplexer TD-550/TRC-80, complete schematic diagram.

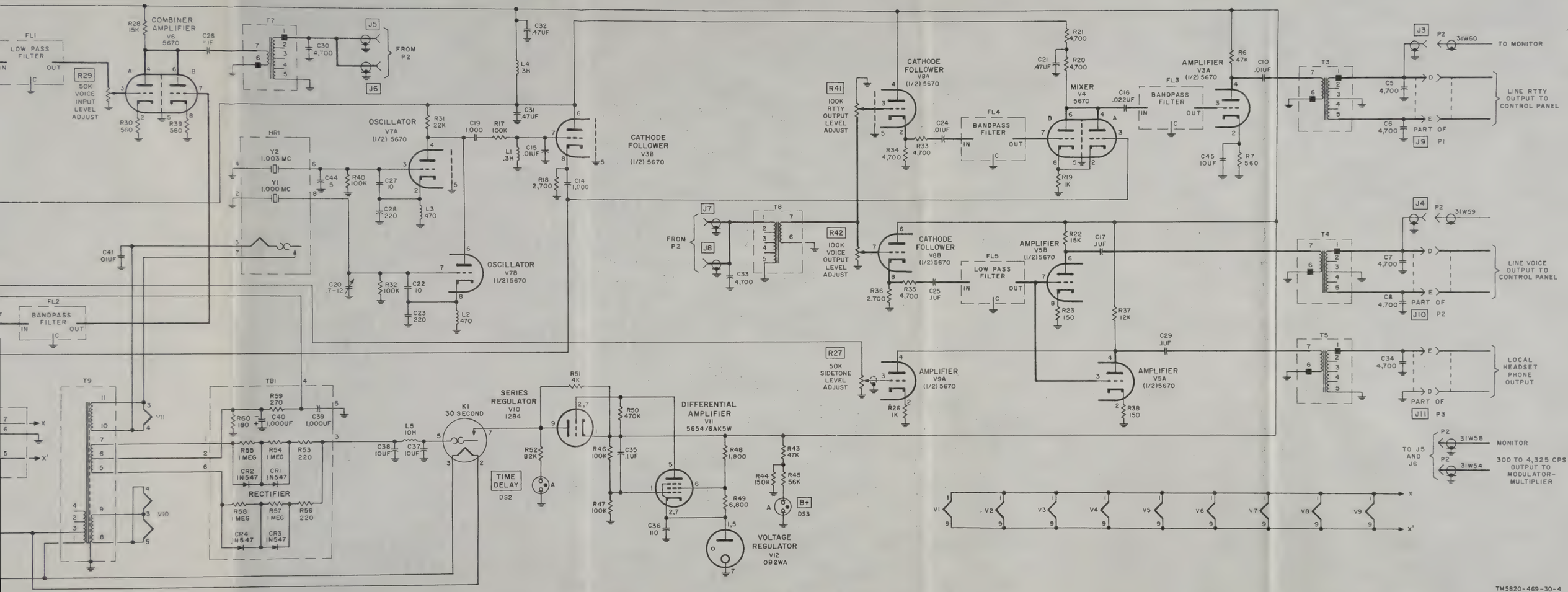
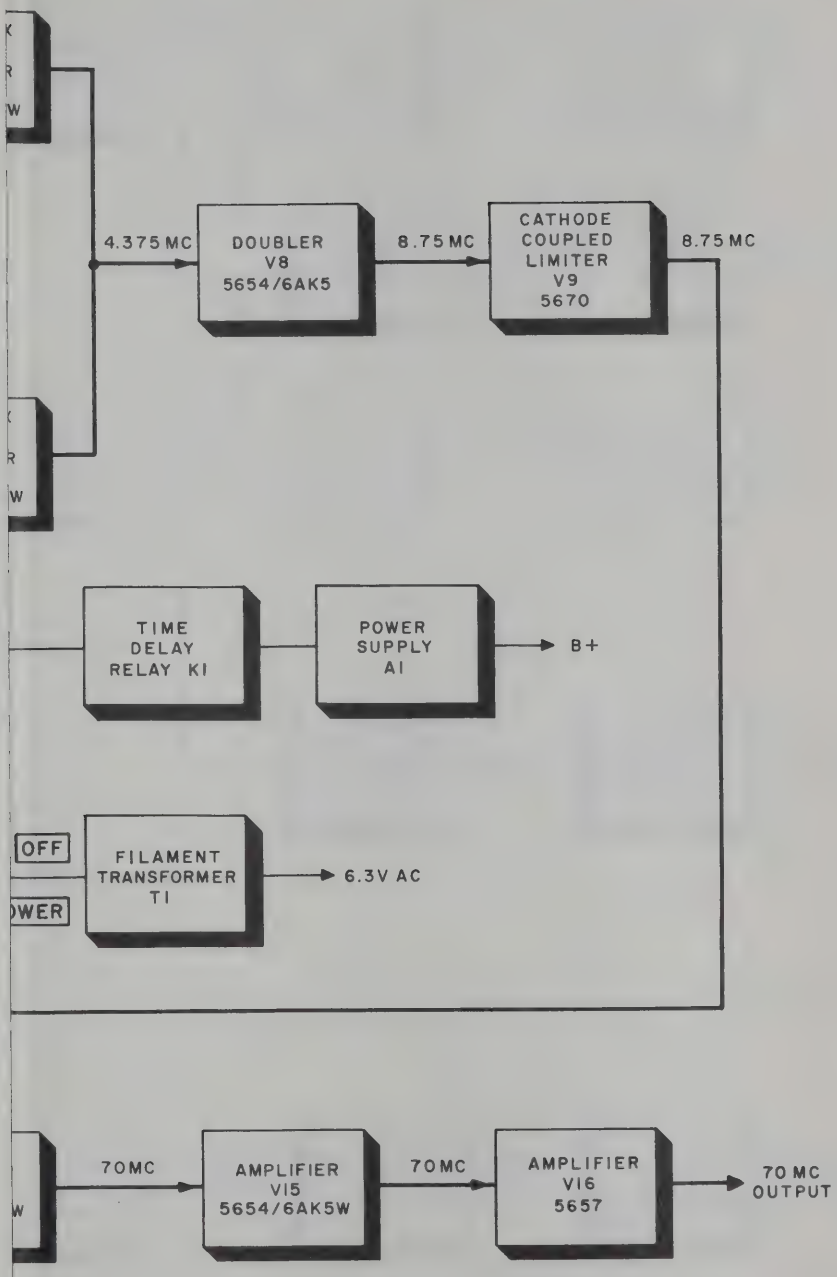


Figure 152. Demultiplexer-Multiplexer TD-550/TRC-80, complete schematic diagram.



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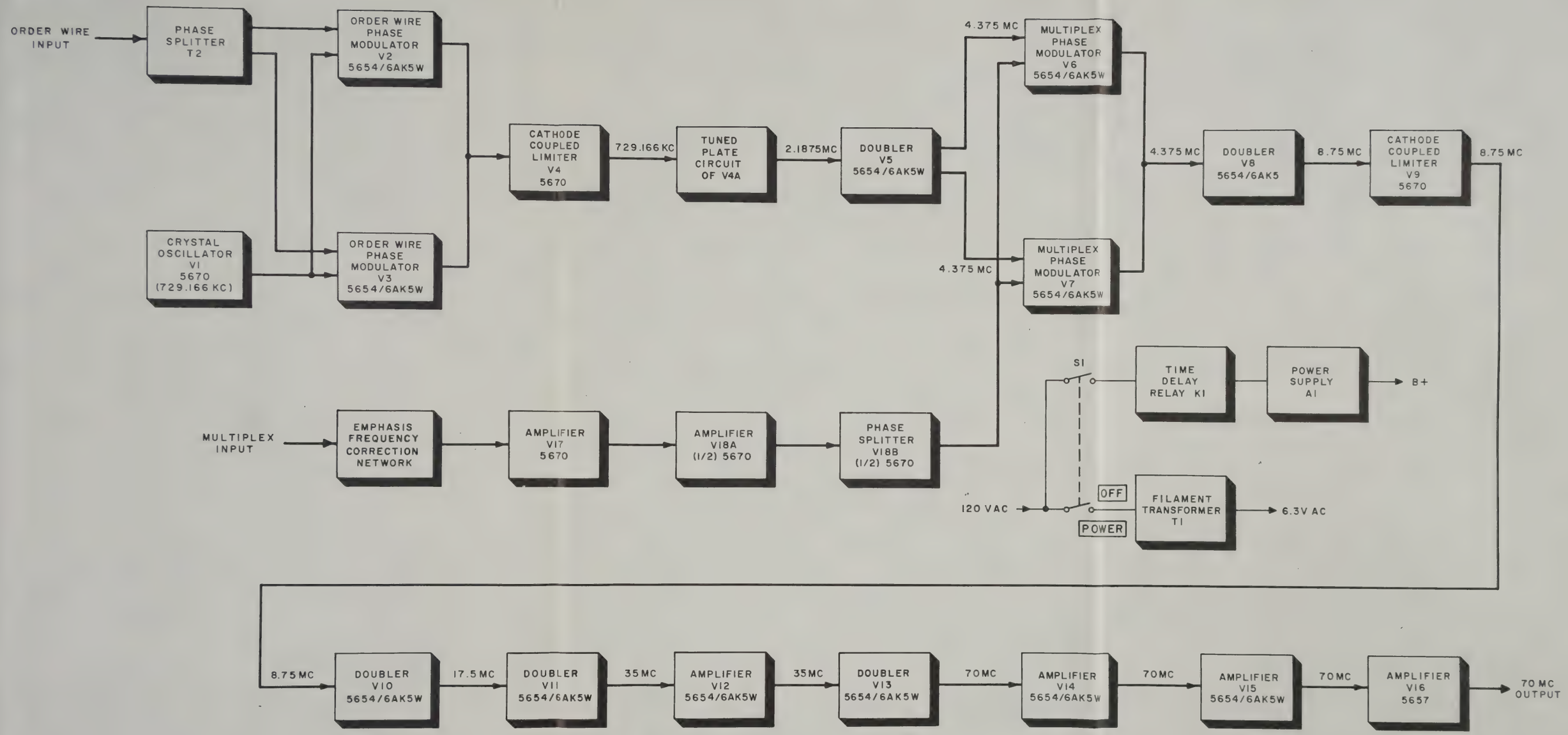
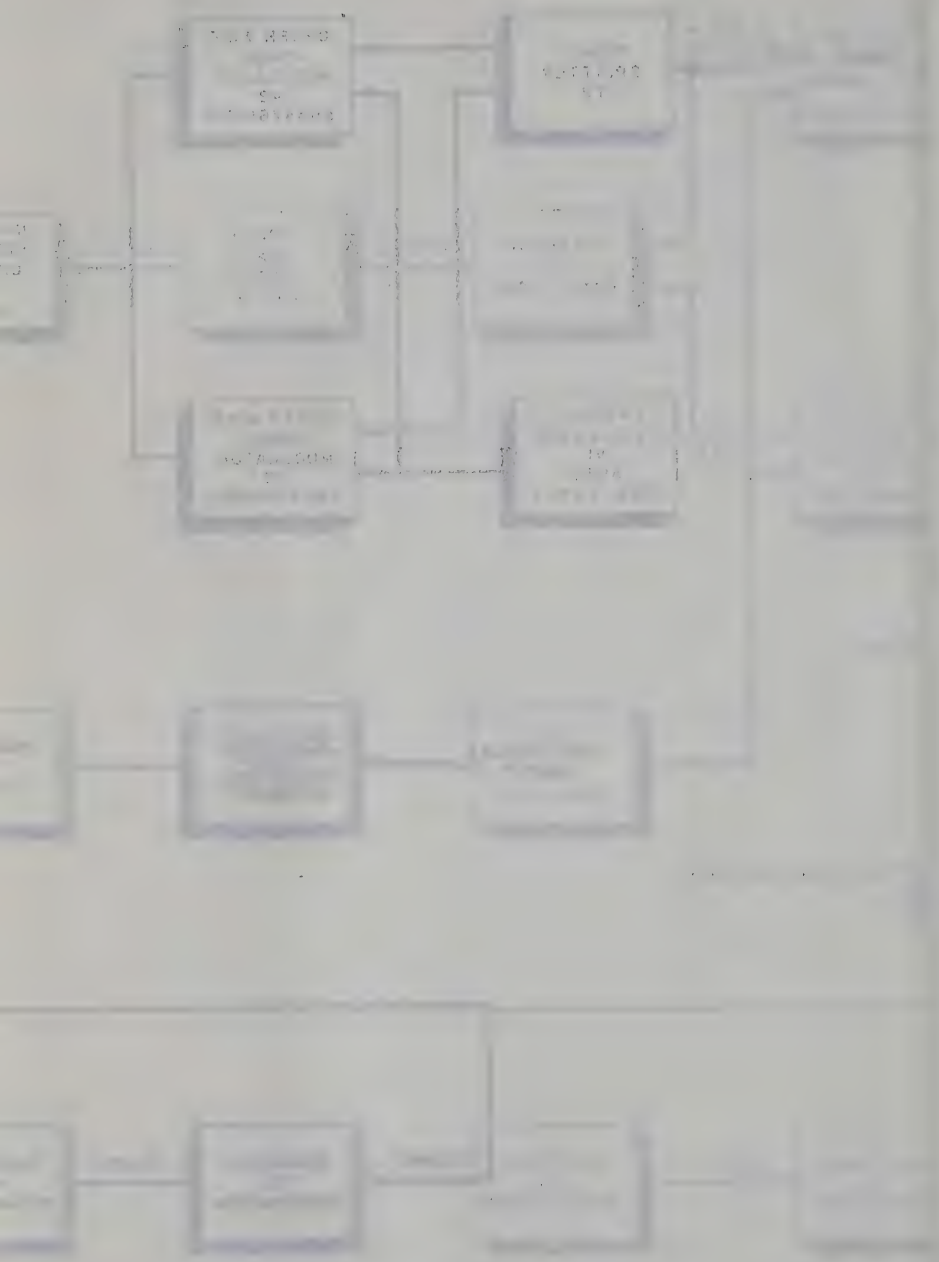


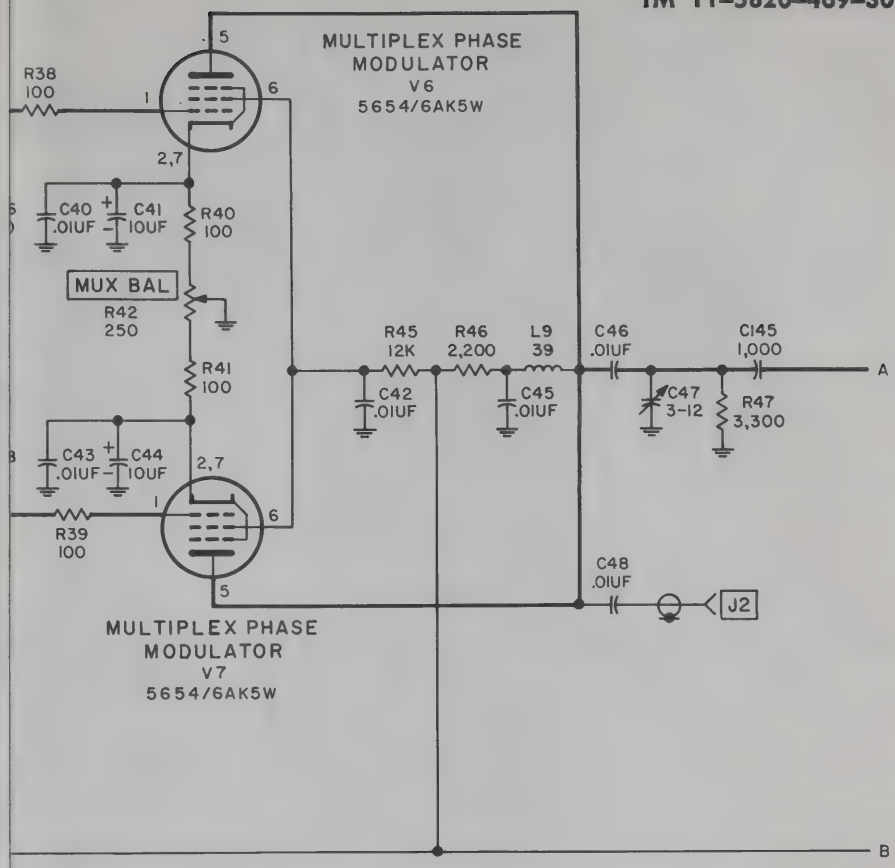
NOTE:

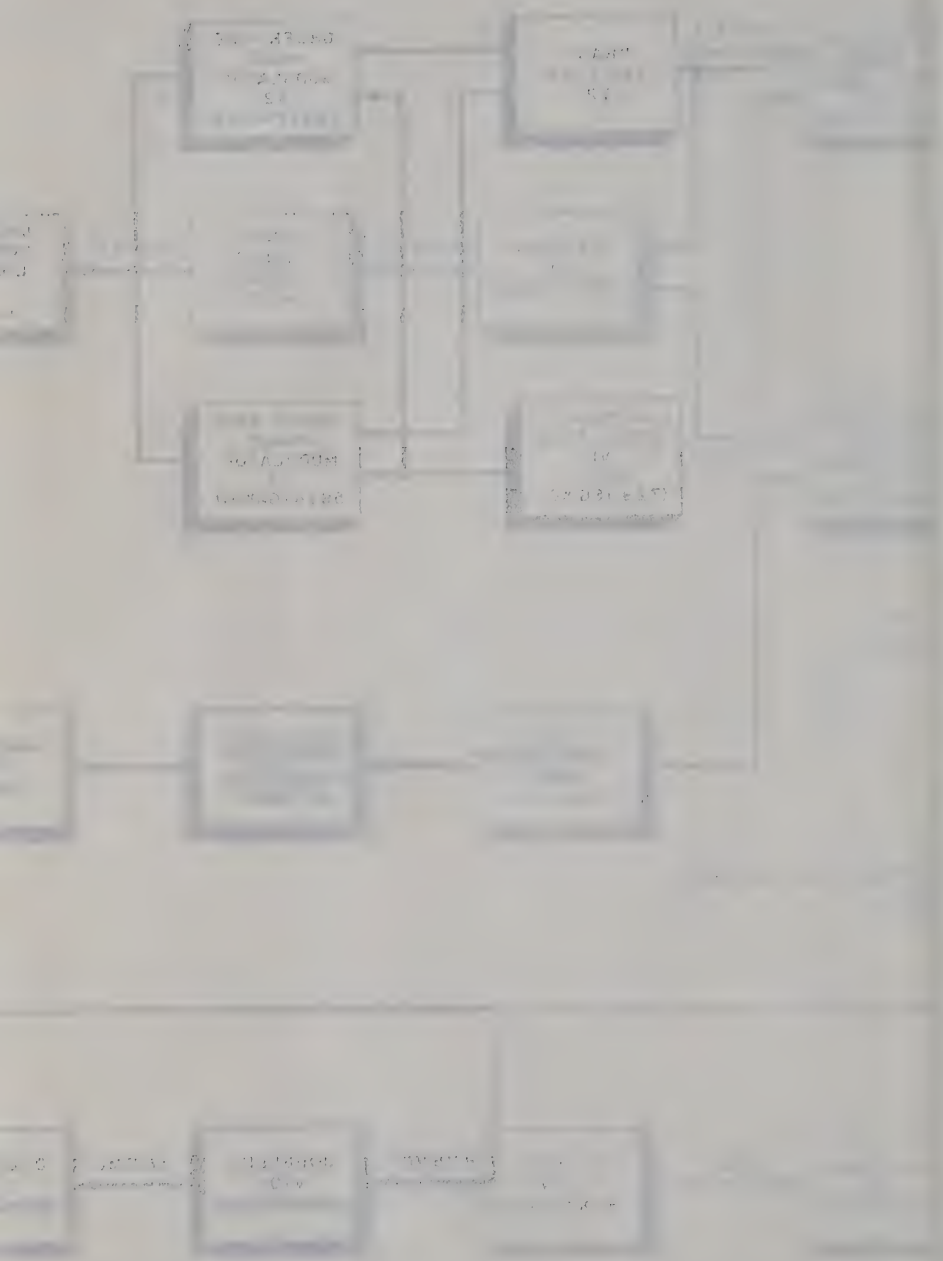
[ ] INDICATES EQUIPMENT MARKING

TM5820-469-30-20

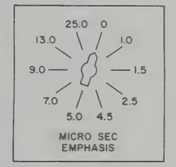
Figure 153. Modulator-Multiplier MD-465/TRC-80, block diagram.




MULTIPLEX PHASE
MODULATOR
V6
5654/6AK5W
R38
100
C40
.01UF
C41
10UF
R40
100
MUX BAL
R42
250
R41
100
C43
.01UF
C44
10UF
R39
100
MULTIPLEX PHASE
MODULATOR
V7
5654/6AK5W
R45
12K
R46
2,200
L9
39
C46
.01UF
C145
1,000
C42
.01UF
C45
.01UF
C47
3-12
R47
3,300
C48
.01UF
J2
A
B
C
D



NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. [ ] INDICATES EQUIPMENT MARKING
3. REMOVE JUMPERS BETWEEN TB1-3 AND TB1-2, AND TB1-4 AND TB1-1 WHEN USING A REGULATED AC FILAMENT SOURCE.
4. T2 TERMINAL IMPEDANCES:
   1-2 600Ω
   3-5 160KΩ
5. UNLESS OTHERWISE INDICATED ALL WAFER SWITCHES ARE VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
6. A1 R111 IS FACTORY INSTALLED TO PRODUCE AN OUTPUT OF 200V DC. THE VALUE MAY NOT BE 470K
7. SYMBOL [ ] INDICATES A ZENER DIODE
8. POSITIONS OF SWITCH S1



9. CONNECTORS ARE VIEWED FROM PIN OR RECEPTACLE SIDE

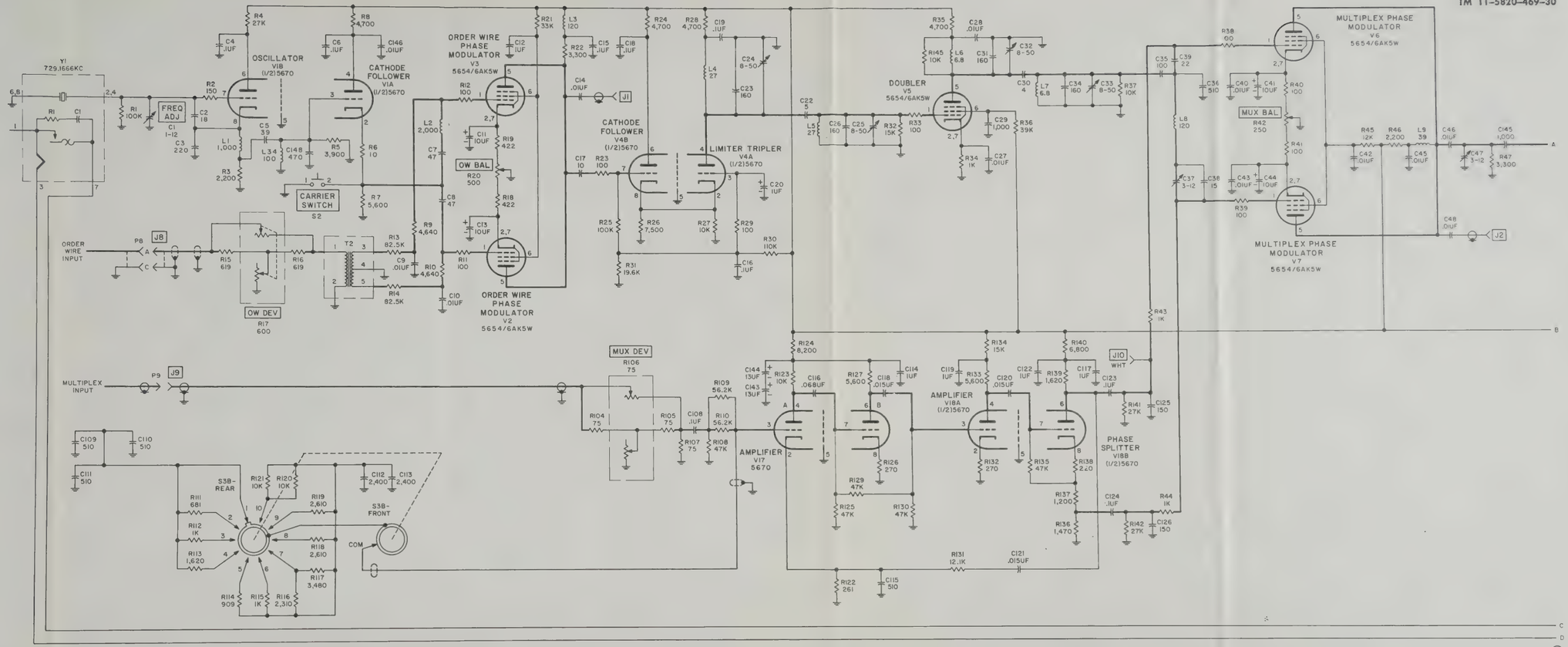
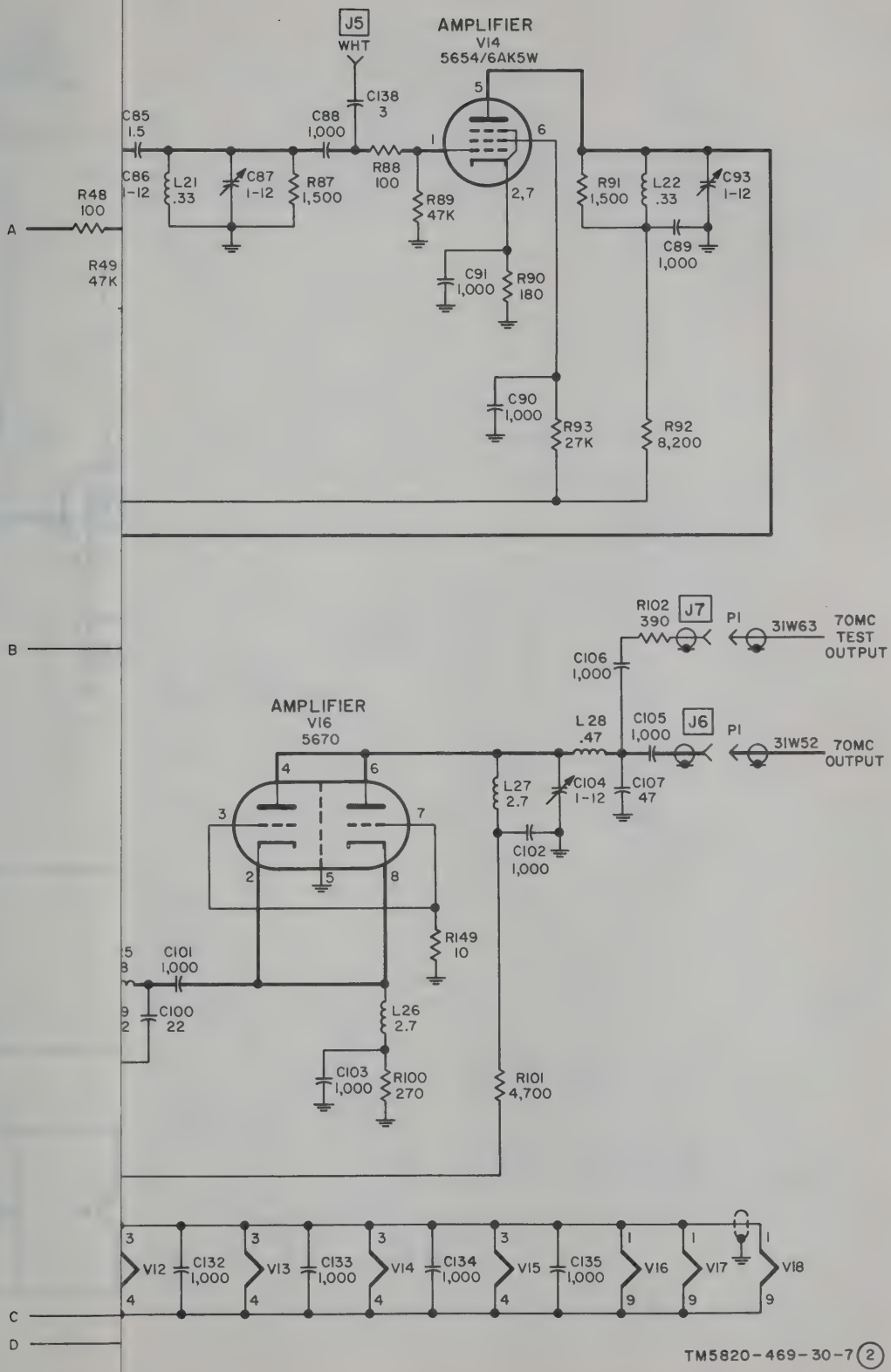


Figure 154. Modulator-Multiplier MD-465/TRC-80, complete schematic diagram (part 1 of 2)


J5
WHT
AMPLIFIER
V14
5654/6AK5W
C138
3
C85
1.5
C88
1,000
C86
1-12
L21
.33
C87
1-12
R87
1,500
R88
100
R89
47K
R48
100
R49
47K
A
B
C
D
C91
1,000
R90
180
C90
1,000
R93
27K
R92
8,200
R91
1,500
L22
.33
C93
1-12
C89
1,000
R102
390
J7
P1
31W63
70MC
TEST
OUTPUT
C106
1,000
AMPLIFIER
V16
5670
L28
.47
C105
1,000
J6
P1
31W52
70MC
OUTPUT
L27
2.7
C104
1-12
C107
47
C102
1,000
R149
10
C101
1,000
C100
22
L26
2.7
C103
1,000
R100
270
R101
4,700
V12
C132
1,000
V13
C133
1,000
V14
C134
1,000
V15
C135
1,000
V16
V17
V18
TM5820-469-30-7 (2)

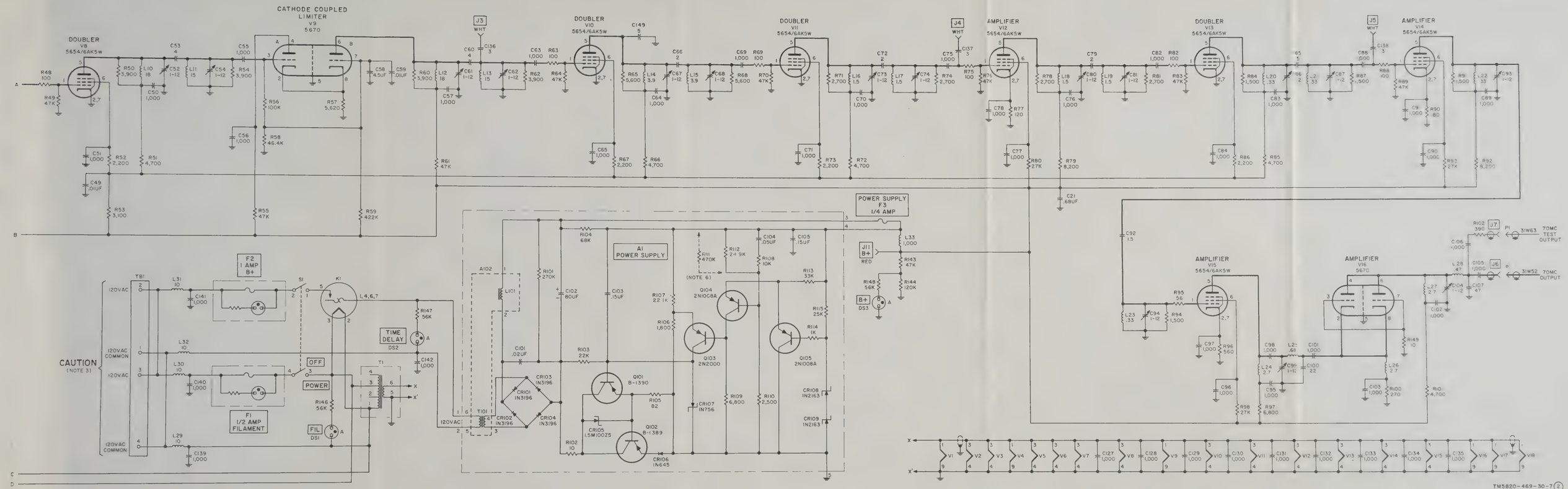
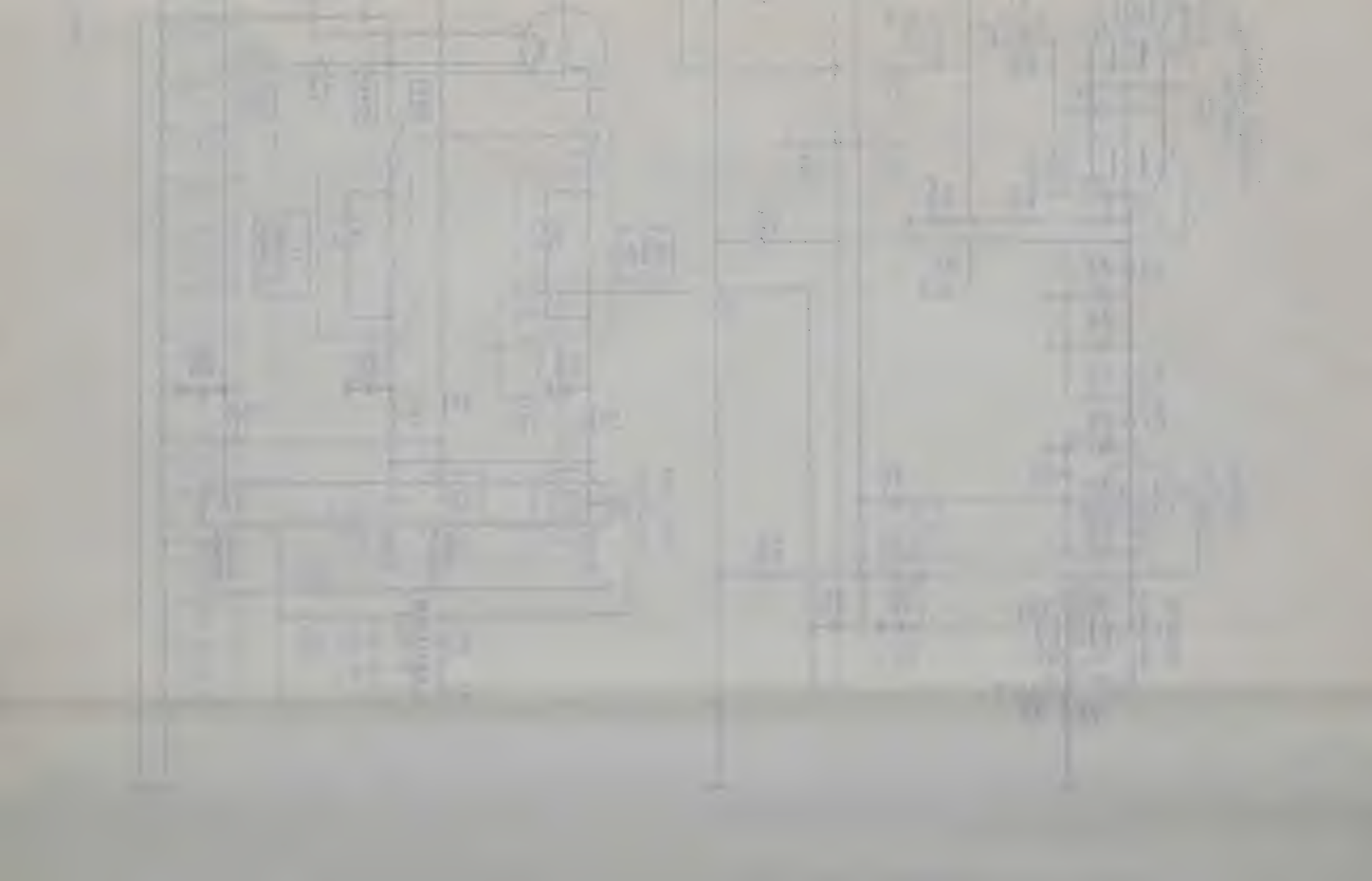
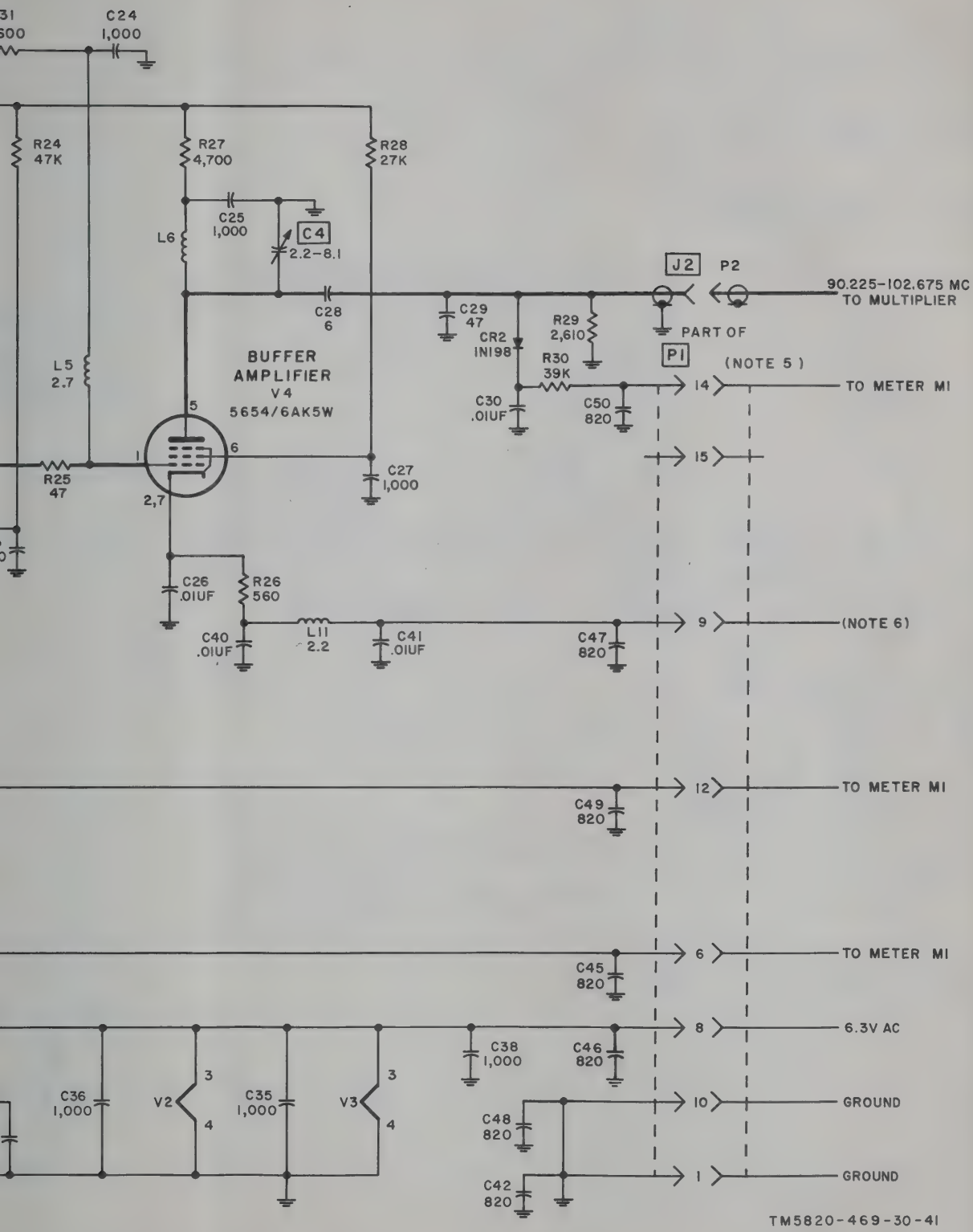
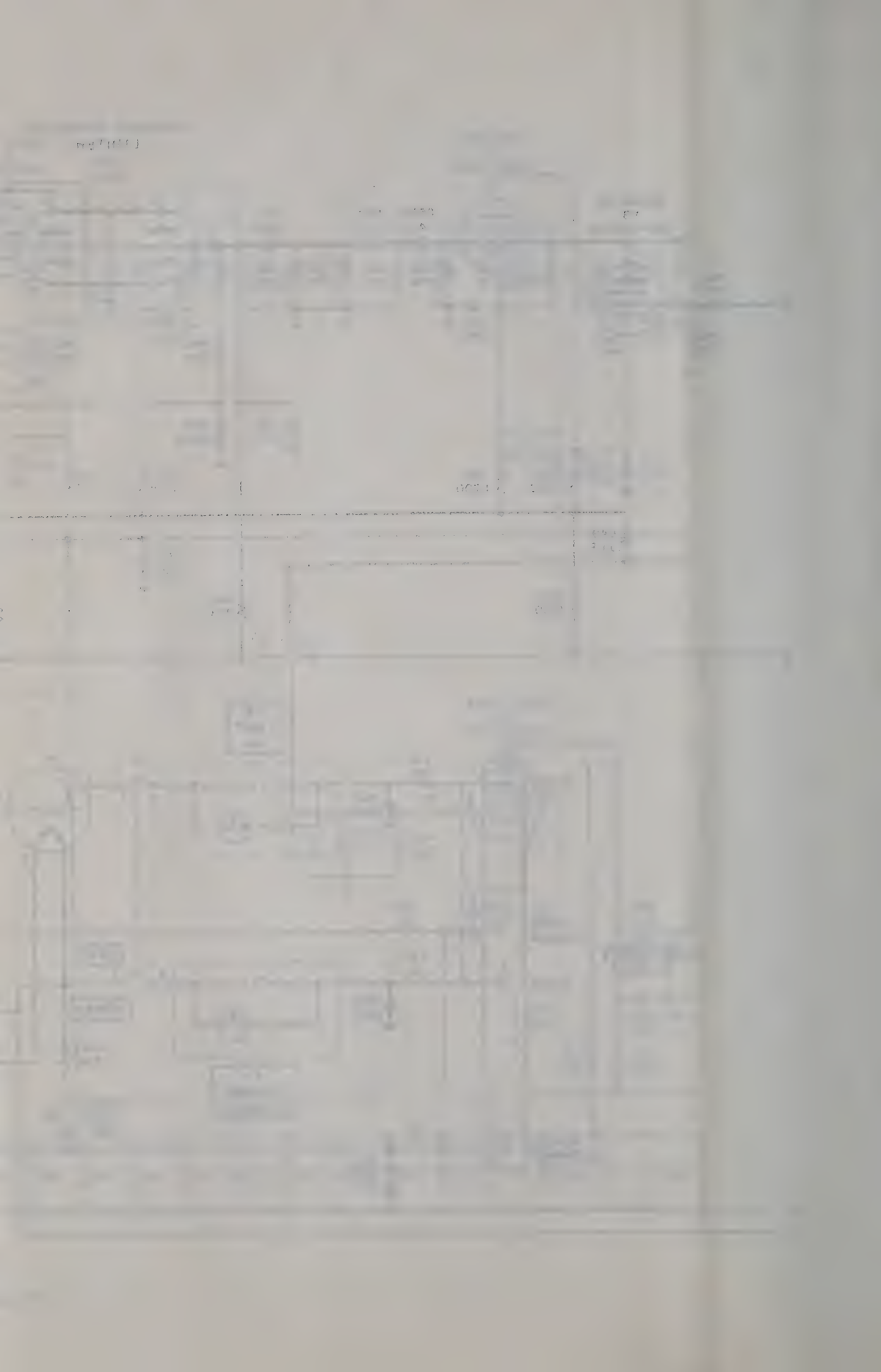


Figure 154. Modulator-Multiplier MD-465/TRC-80, complete schematic diagram (part 2 of 2).




C24
1,000
R24
47K
R27
4,700
R28
27K
C25
1,000
L6
C4
2.2-8.1
J2
P2
90.225-102.675 MC
TO MULTIPLIER
PART OF
P1
(NOTE 5)
C28
6
C29
47
CR2
IN198
R29
2,610
R30
39K
L5
2.7
BUFFER
AMPLIFIER
V4
5654/6AK5W
C30
.01UF
C50
820
14
TO METER MI
15
R25
47
C27
1,000
C26
.01UF
R26
560
9
(NOTE 6)
C40
.01UF
L11
2.2
C41
.01UF
C47
820
12
TO METER MI
C49
820
6
TO METER MI
C45
820
8
6.3V AC
C38
1,000
C46
820
C36
1,000
V2
V3
C35
1,000
10
GROUND
C48
820
1
GROUND
C42
820
TM5820-469-30-41



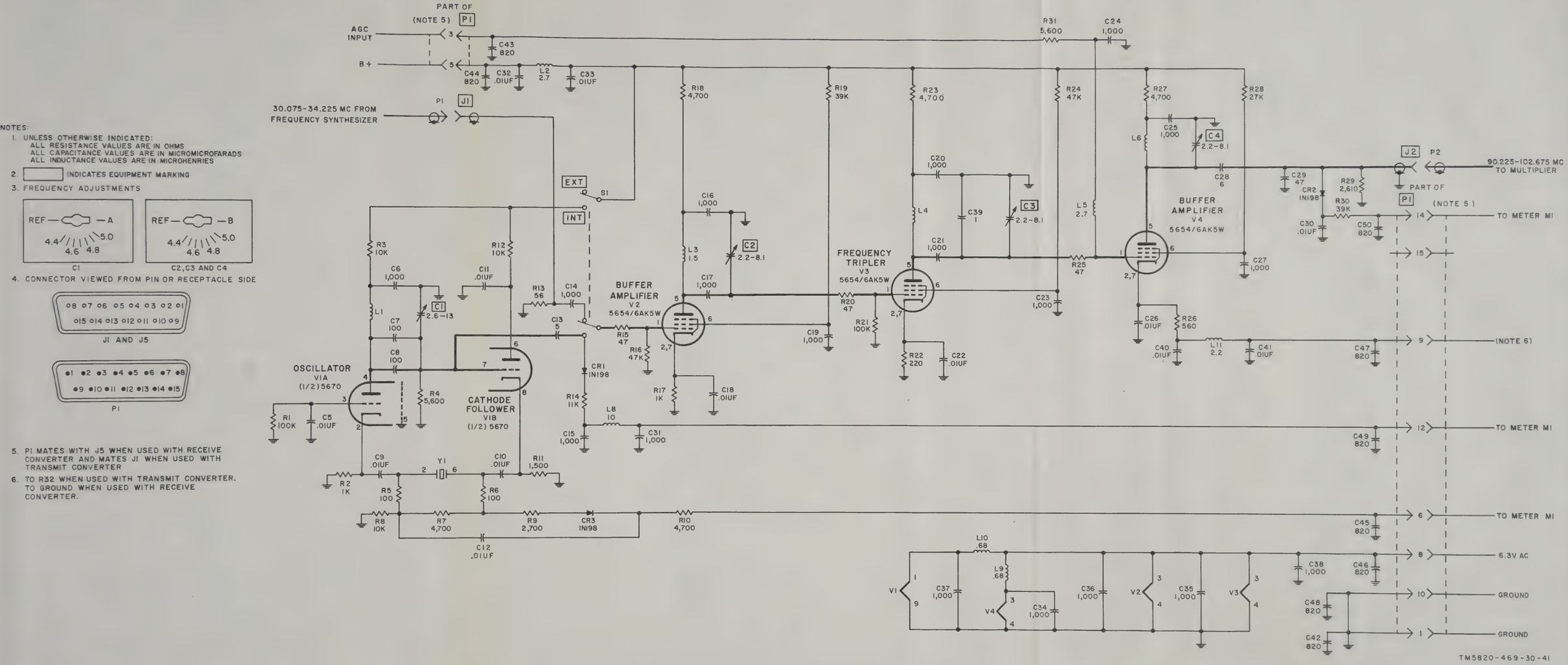
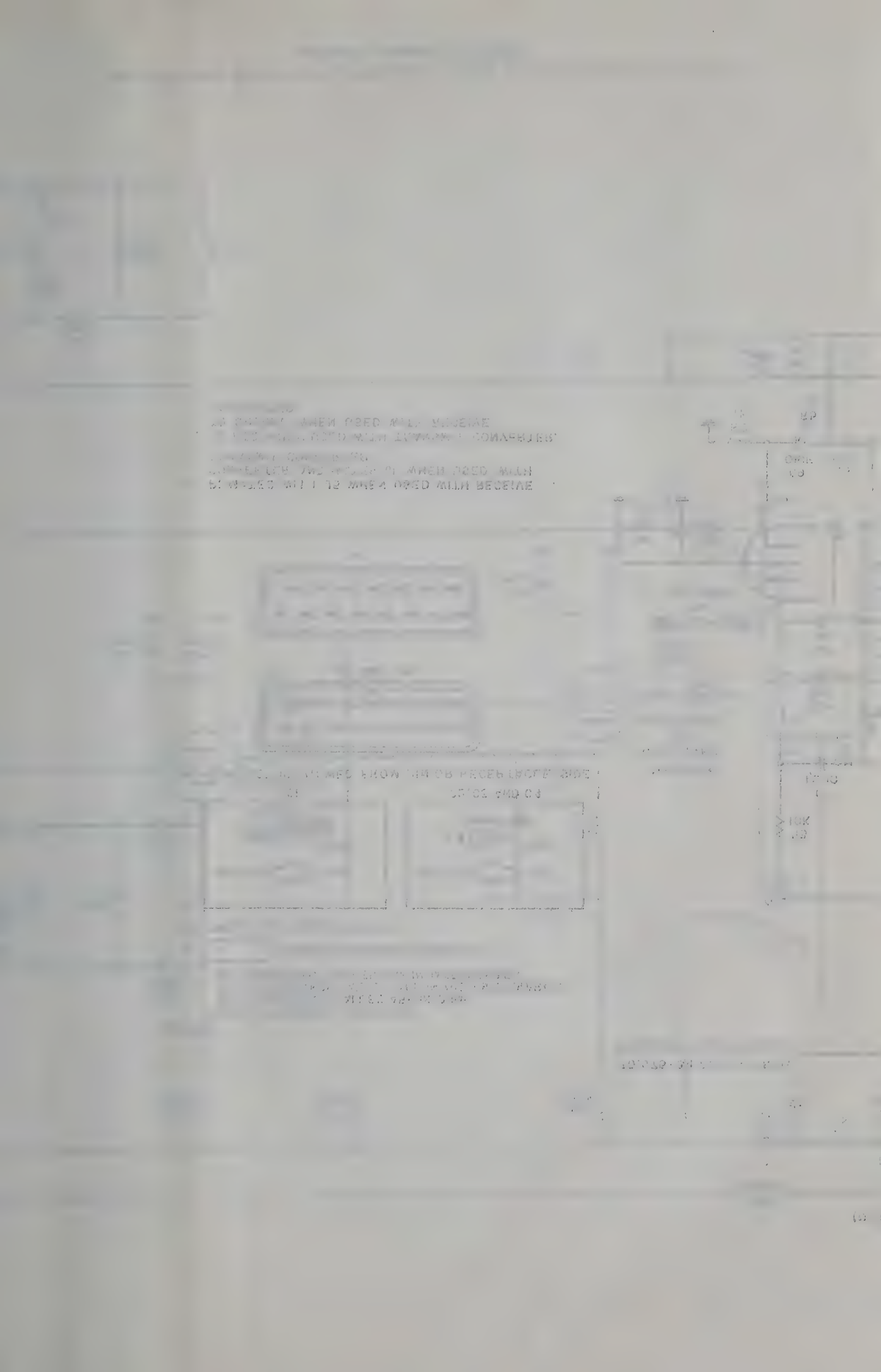
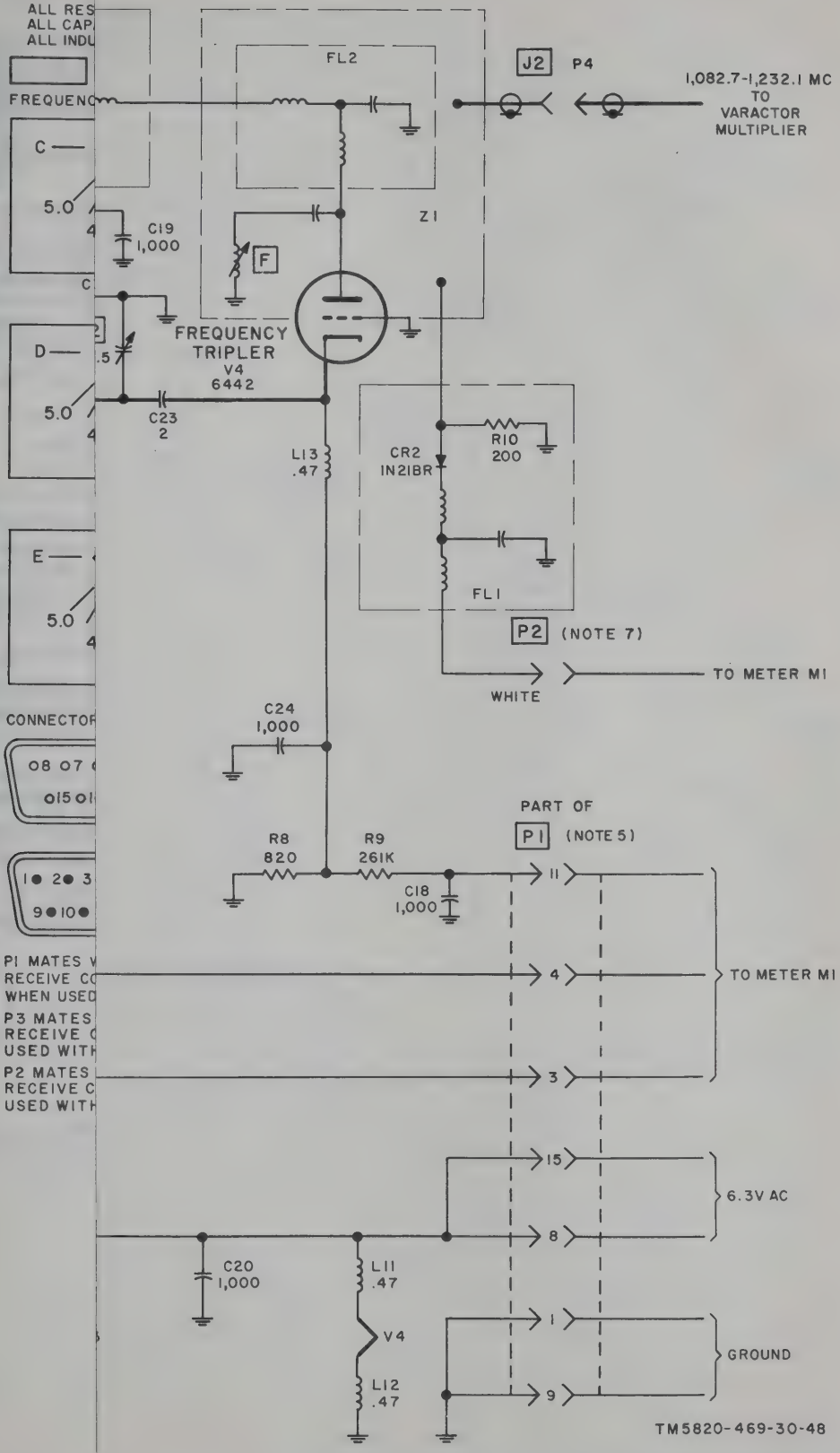

NOTES:
1. UNLESS OTHERWISE INDICATED:
ALL RESISTANCE VALUES ARE IN OHMS
ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. INDICATES EQUIPMENT MARKING
3. FREQUENCY ADJUSTMENTS
REF — A
4.4 4.6 4.8 5.0
C1
REF — B
4.4 4.6 4.8 5.0
C2, C3 AND C4
4. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE
08 07 06 05 04 03 02 01
015 014 013 012 011 010 09
J1 AND J5
01 02 03 04 05 06 07 08
09 010 011 012 013 014 015
P1
5. P1 MATES WITH J5 WHEN USED WITH RECEIVE CONVERTER AND MATES J1 WHEN USED WITH TRANSMIT CONVERTER
6. TO R32 WHEN USED WITH TRANSMIT CONVERTER. TO GROUND WHEN USED WITH RECEIVE CONVERTER.
PART OF (NOTE 5) P1
AGC INPUT
B+
30.075-34.225 MC FROM FREQUENCY SYNTHESIZER
P1 J1
EXT
INT
S1
OSCILLATOR V1A (1/2) 5670
CATHODE FOLLOWER V1B (1/2) 5670
BUFFER AMPLIFIER V2 5654/6AK5W
FREQUENCY TRIPLER V3 5654/6AK5W
BUFFER AMPLIFIER V4 5654/6AK5W
C1 2.6-13
C2 2.2-8.1
C3 2.2-8.1
C4 2.2-8.1
J2 P2
90.225-102.675 MC TO MULTIPLIER
PART OF P1 (NOTE 5)
TO METER MI
(NOTE 6)
TO METER MI
TO METER MI
6.3V AC
GROUND
GROUND
TM5820-469-30-41

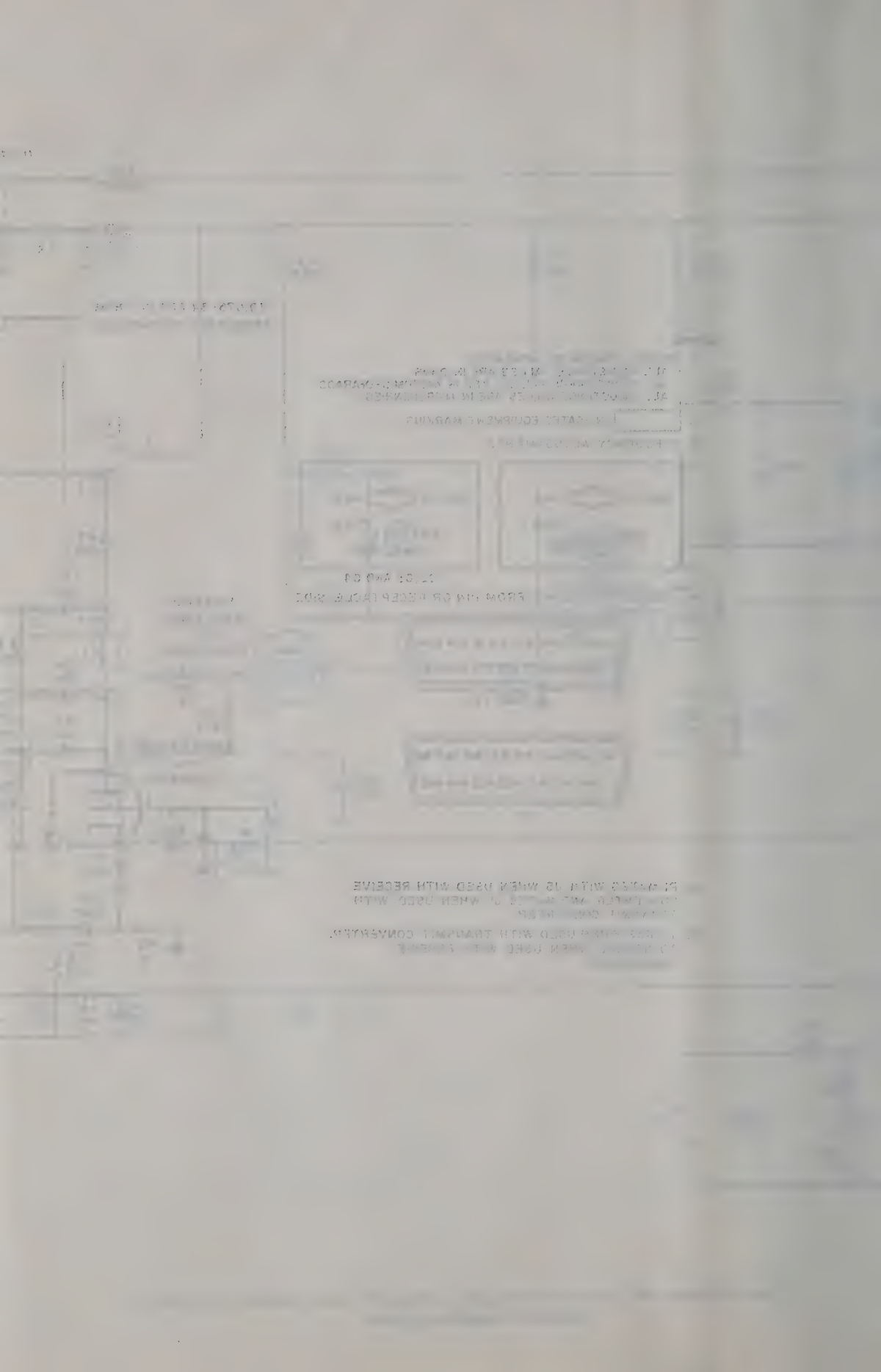
Figure 155. Oscillator unit A2 (part of Amplifier-Converter AM-3303/TRC-80), complete schematic diagram.



NOTES:

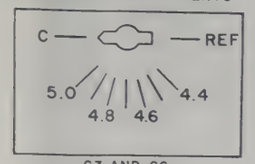
1. UNLESS O
   ALL RES
   ALL CAP
   ALL INDU
2. [illegible]
3. FREQUENC
4. CONNECTOR
5. P1 MATES W
   RECEIVE CO
   WHEN USED
6. P3 MATES
   RECEIVE C
   USED WITH
7. P2 MATES
   RECEIVE C
   USED WITH



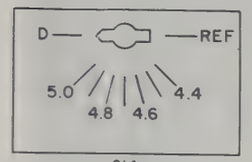


NOTES:

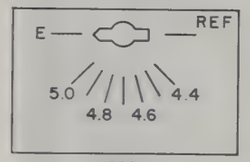
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. [ ] INDICATES EQUIPMENT MARKING
3. FREQUENCY ADJUSTMENTS



C3 AND C6

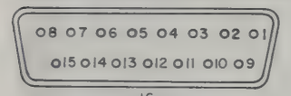


C14

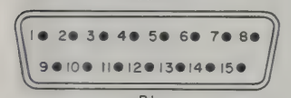


C22

4. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



J6



P1

5. P1 MATES WITH J6 WHEN USED WITH THE RECEIVE CONVERTER AND MATES WITH J2 WHEN USED WITH THE TRANSMIT CONVERTER
6. P3 MATES WITH J9 WHEN USED WITH THE RECEIVE CONVERTER AND WITH J4 WHEN USED WITH THE TRANSMIT CONVERTER.
7. P2 MATES WITH J10 WHEN USED WITH THE RECEIVE CONVERTER AND WITH J3 WHEN USED WITH THE TRANSMIT CONVERTER.

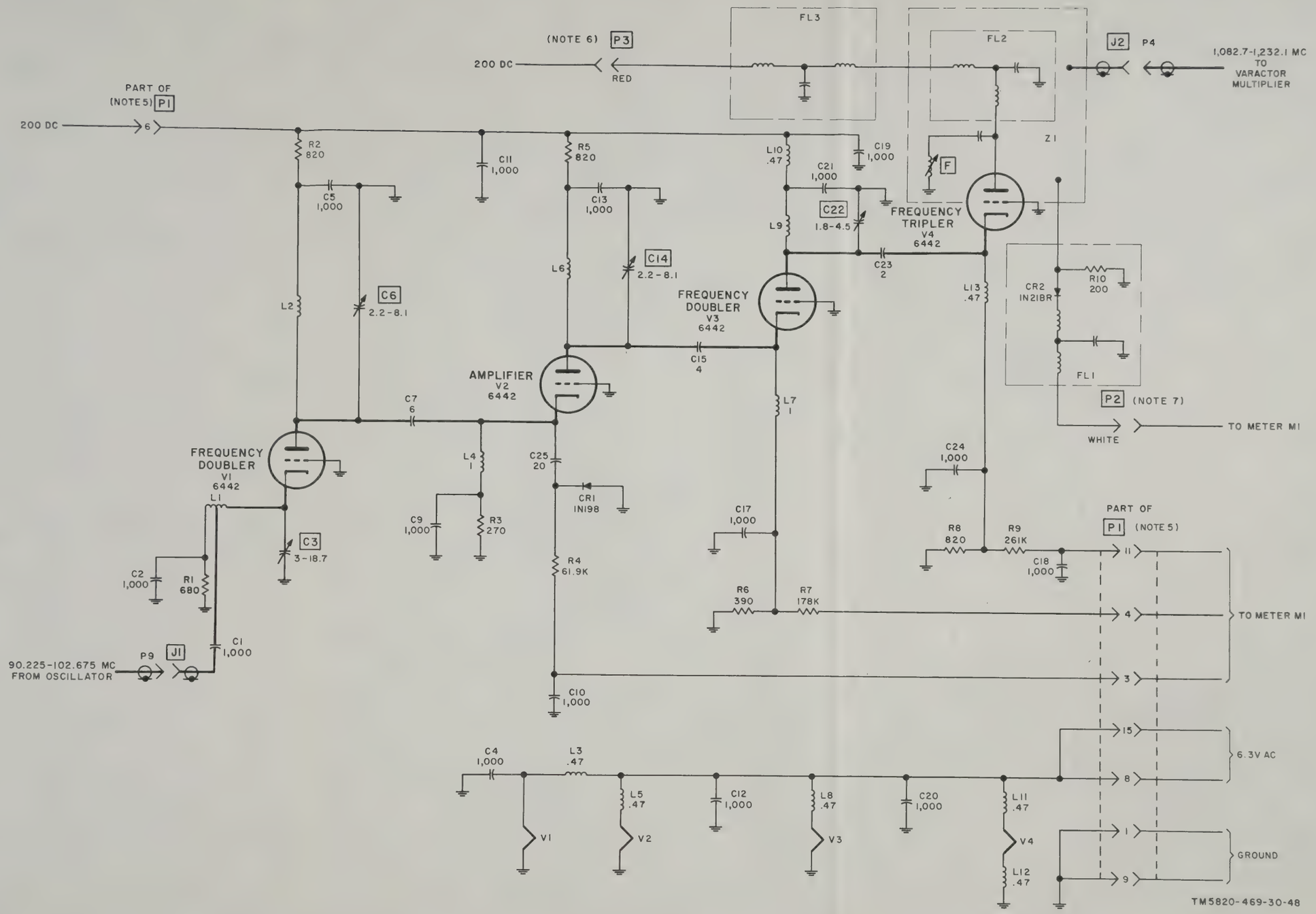
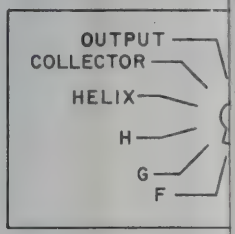


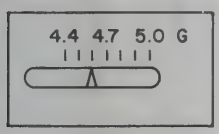
Figure 156. Oscillator unit A3 (part of Amplifier-Converter AM-3303/TRC-80), complete schematic diagram.

NOTES:

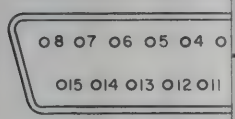
1. UNLESS OTHERWISE INDI
   ALL RESISTANCE VAL
   ALL CAPACITANCE VA
   MICROMICROFARADS
   ALL INDUCTANCE VALU
2. SYMBOL (TC) INDICATES
3. ▭ INDICATES EQ
4. ALL WAFER SWITCHES
   THE KNOB OR DRIVEN E
5. SWITCH POSITIONS OF S

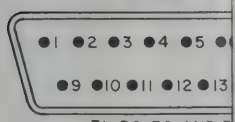


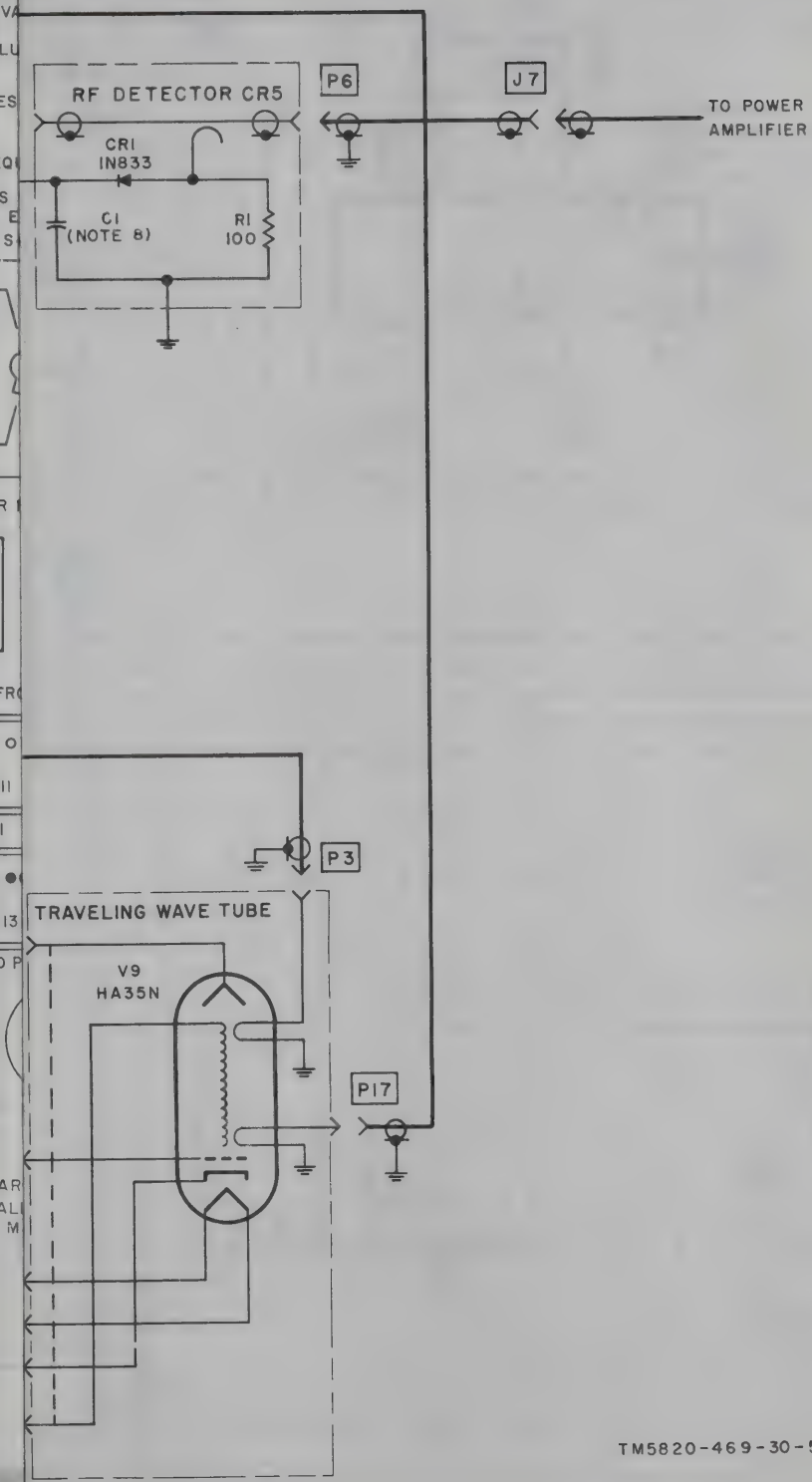
6. VARACTOR MULTIPLIER



7. CONNECTOR VIEWED FR





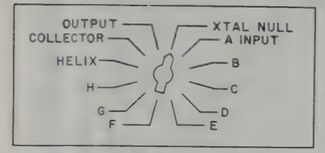


8. CAPACITOR C1 IS A PAR
9. R111 IS FACTORY INSTALL
   200VDC. THE VALUE M

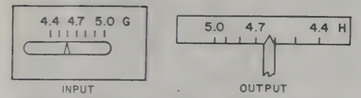
TM5820-469-30-5

NOTES:

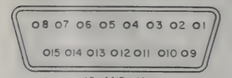
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. SYMBOL (VC) INDICATES VARIABLE CAPACITANCE DIODE
3. [ ] INDICATES EQUIPMENT MARKING
4. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE THE KNOB OR DRIVEN END
5. SWITCH POSITIONS OF S4

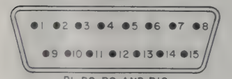


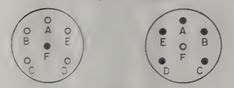
6. VARACTOR MULTIPLIER FREQUENCY:



7. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE







8. CAPACITOR C1 IS A PART OF THE DETECTOR ASSEMBLY.
9. R111 IS FACTORY INSTALLED TO PRODUCE AN OUTPUT OF 200VDC. THE VALUE MAY NOT BE 470K

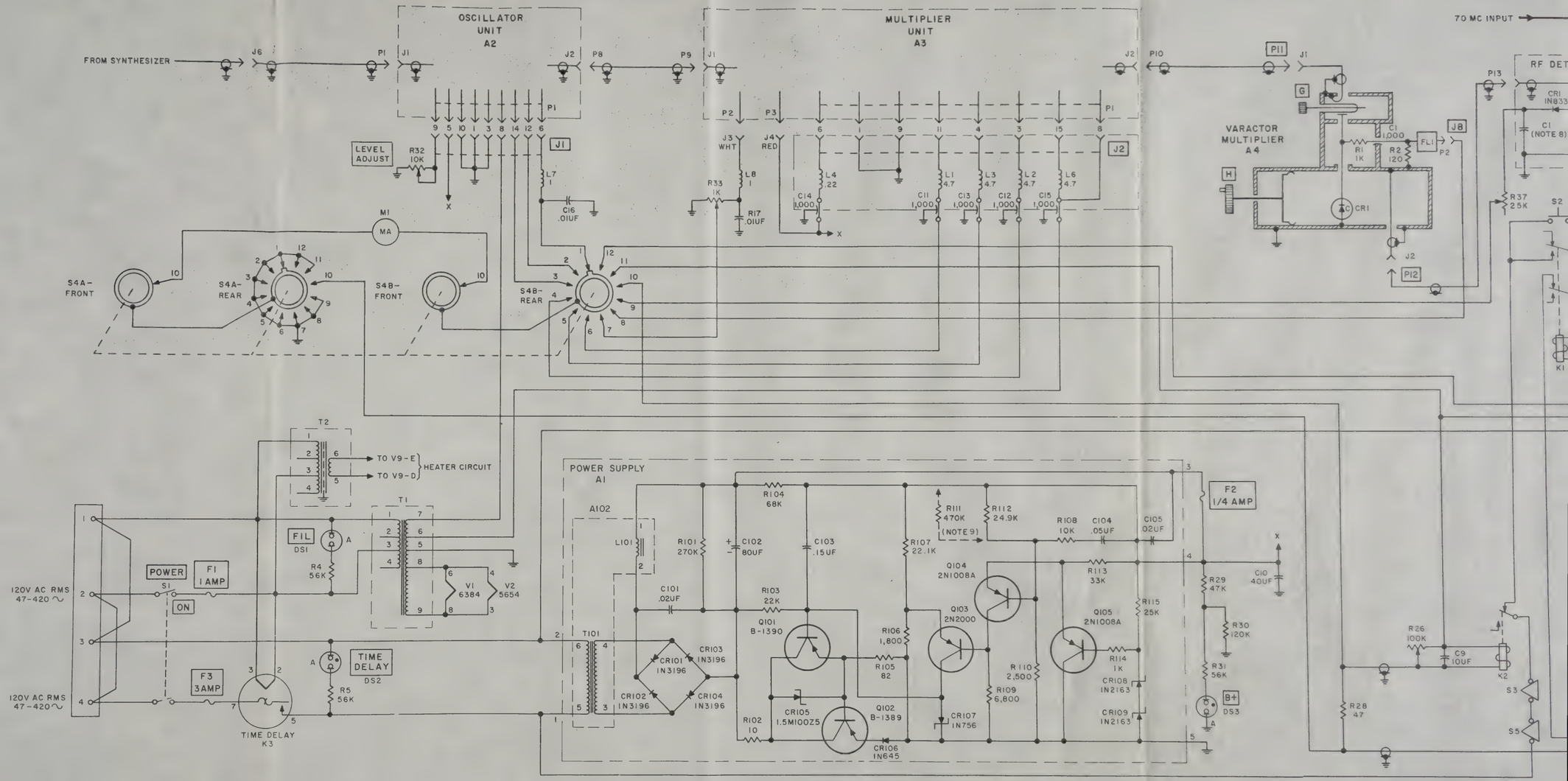
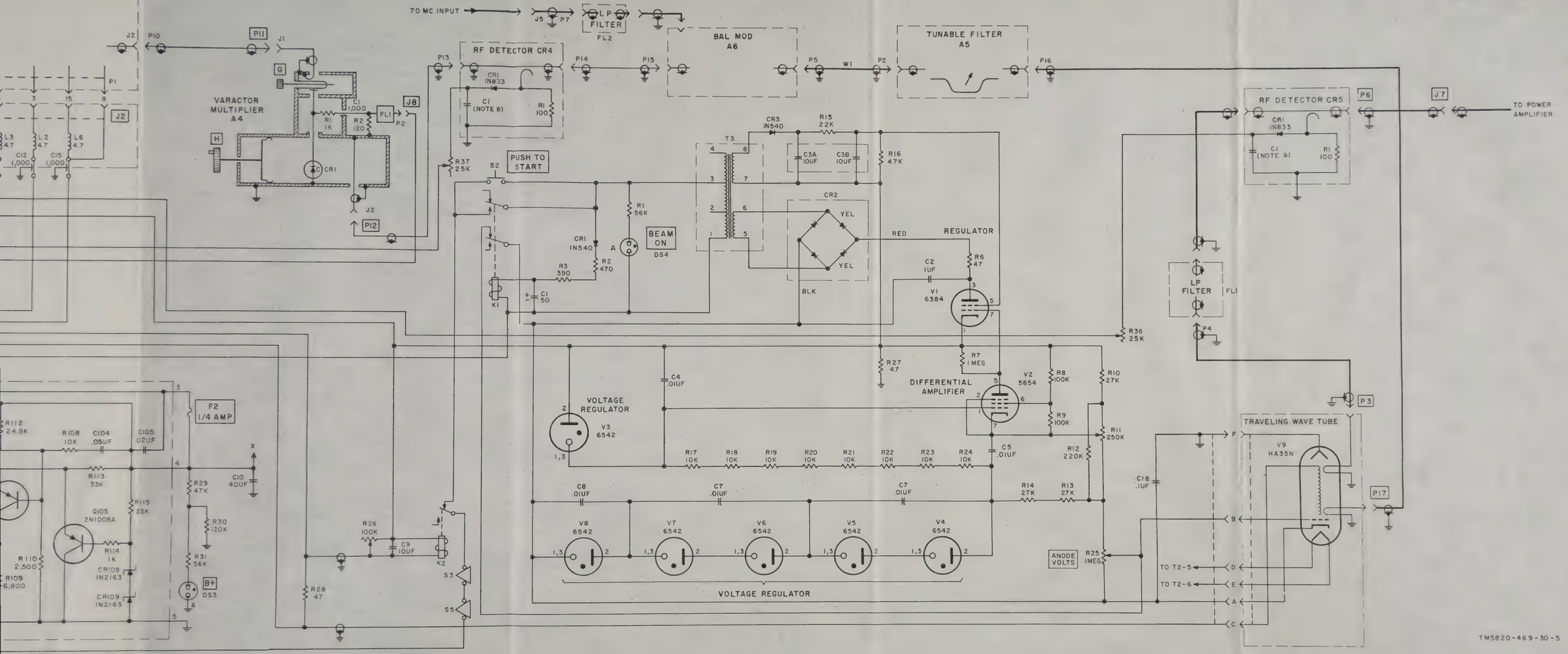
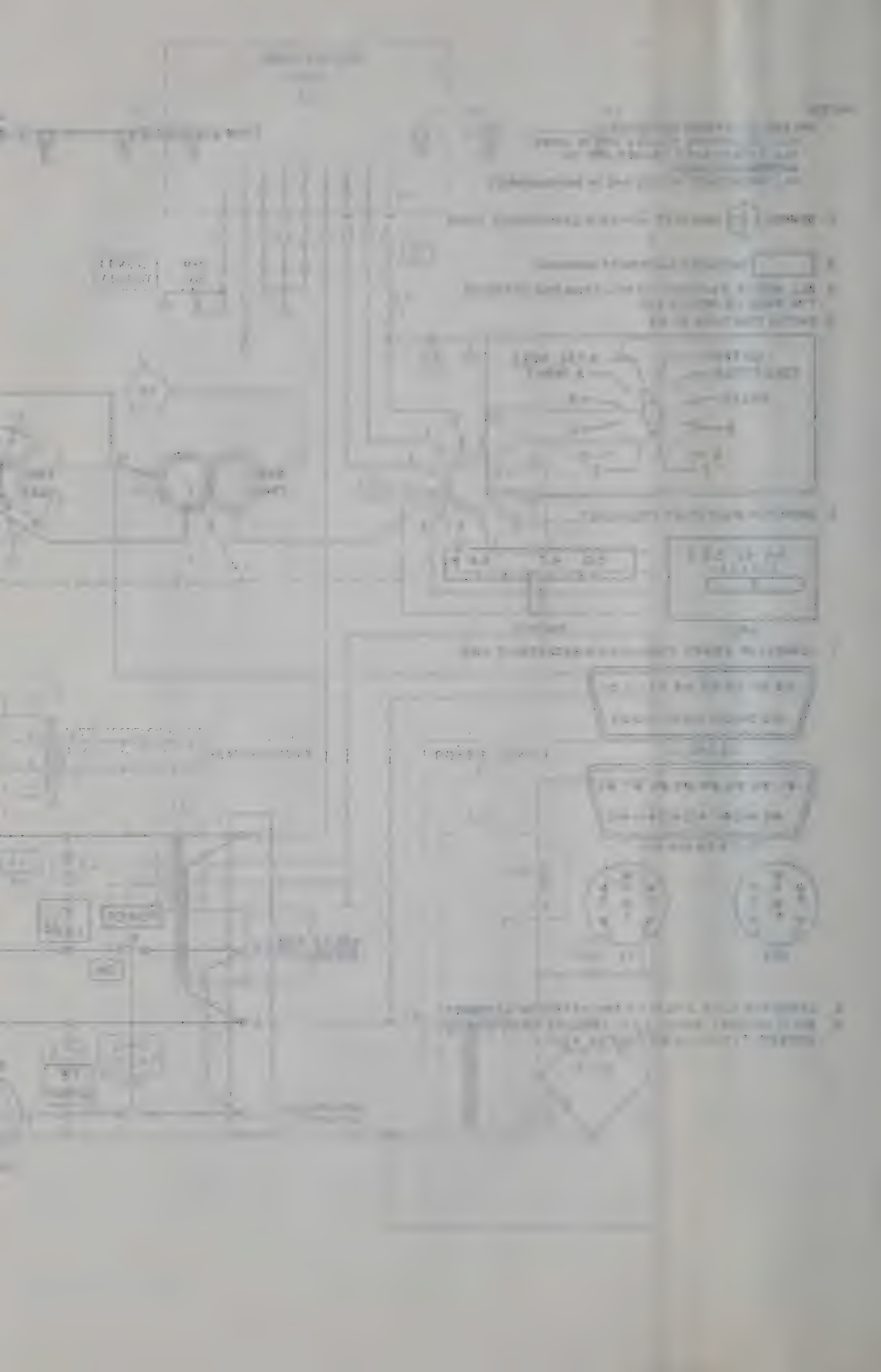


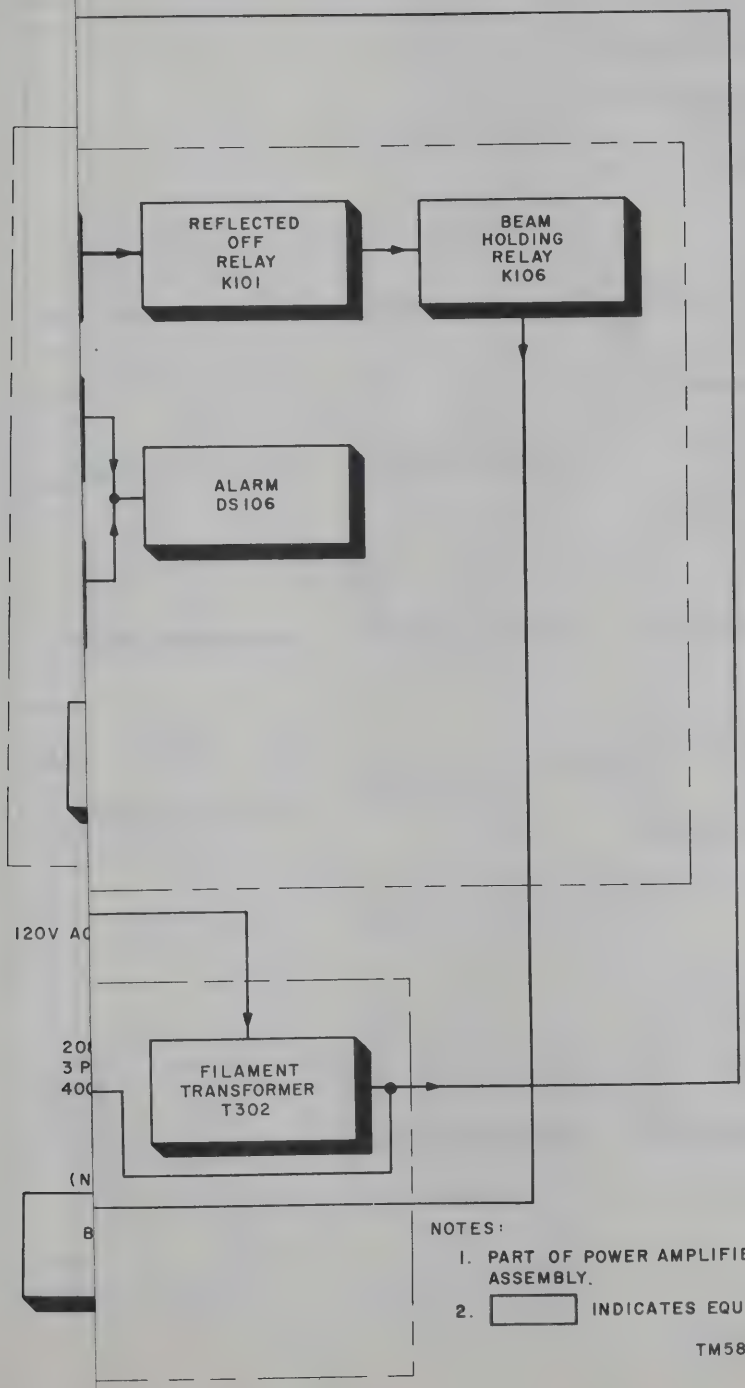
Figure 157. Amplifier-Converter AM-3303/TRC-80, complete schematic diagram.

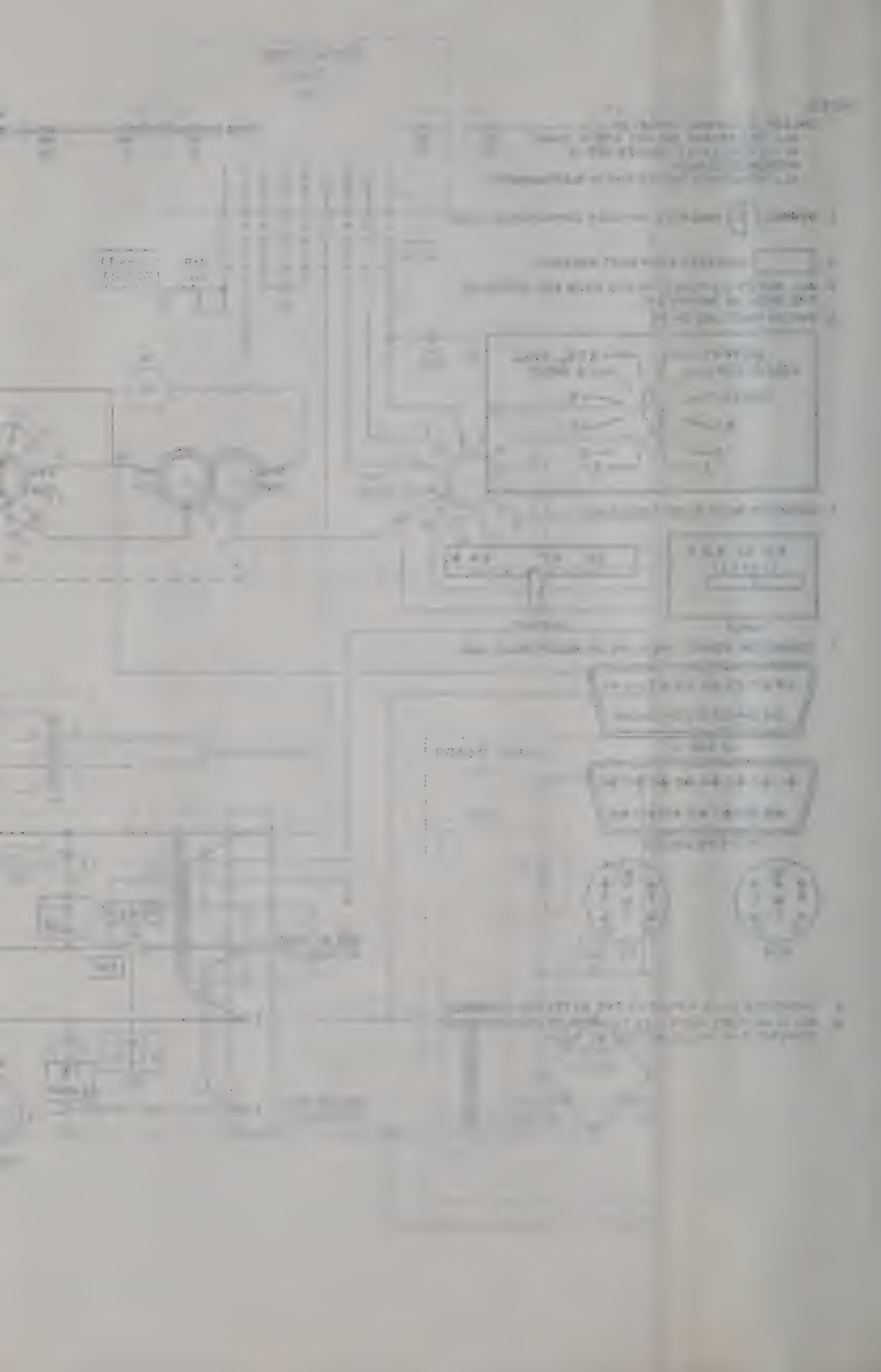


TM5820-469-30-5

Figure 157. Amplifier-Converter AM-3303/TRC-80, complete schematic diagram.




MC
NA
REFLECTED OFF RELAY K101
BEAM HOLDING RELAY K106
ALARM DS106
120V AC
FILAMENT TRANSFORMER T302
NOTES:
1. PART OF POWER AMPLIFIER CABINET ASSEMBLY.
2. INDICATES EQUIPMENT MARKING.
TM5820-469-30-40



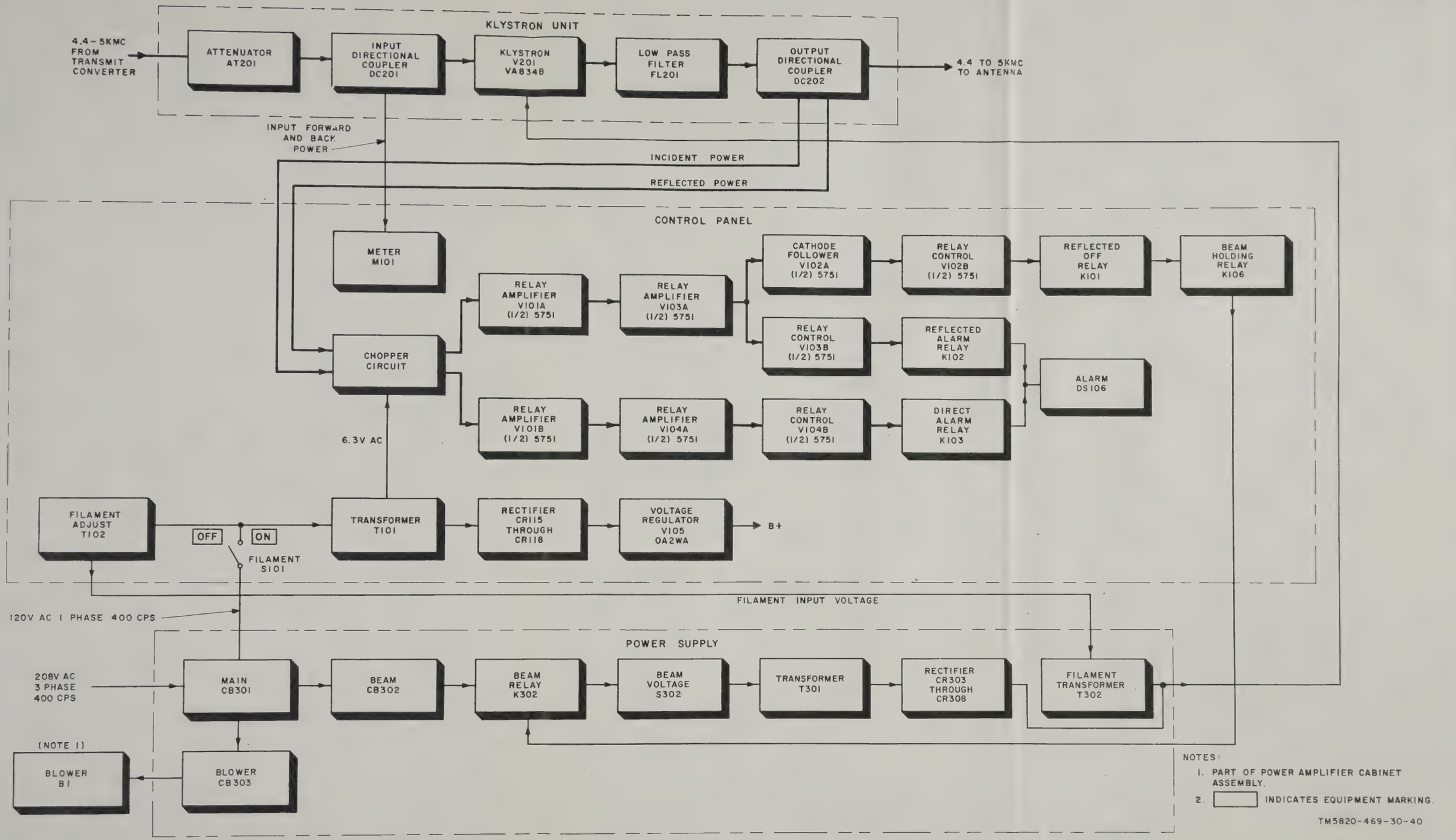
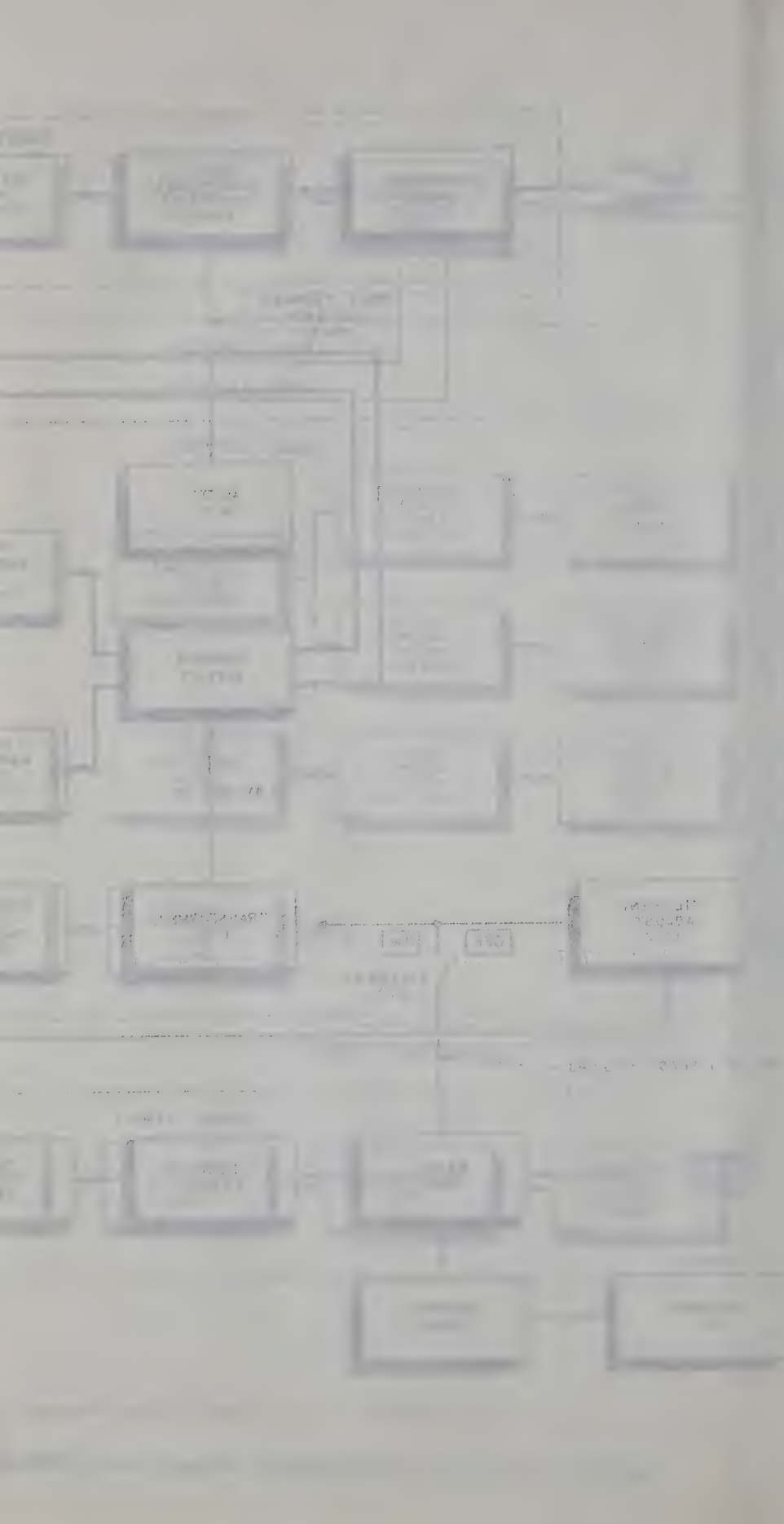
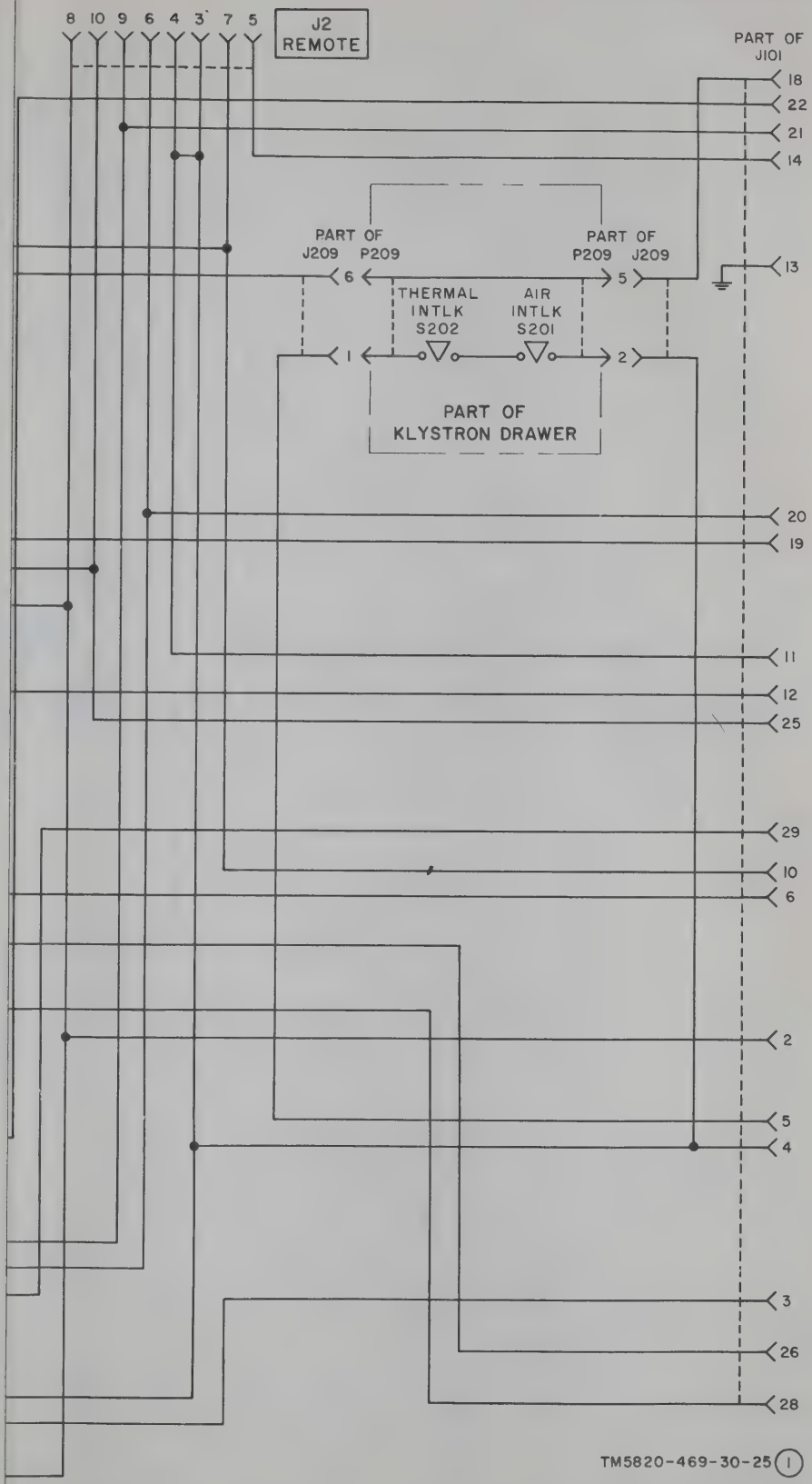
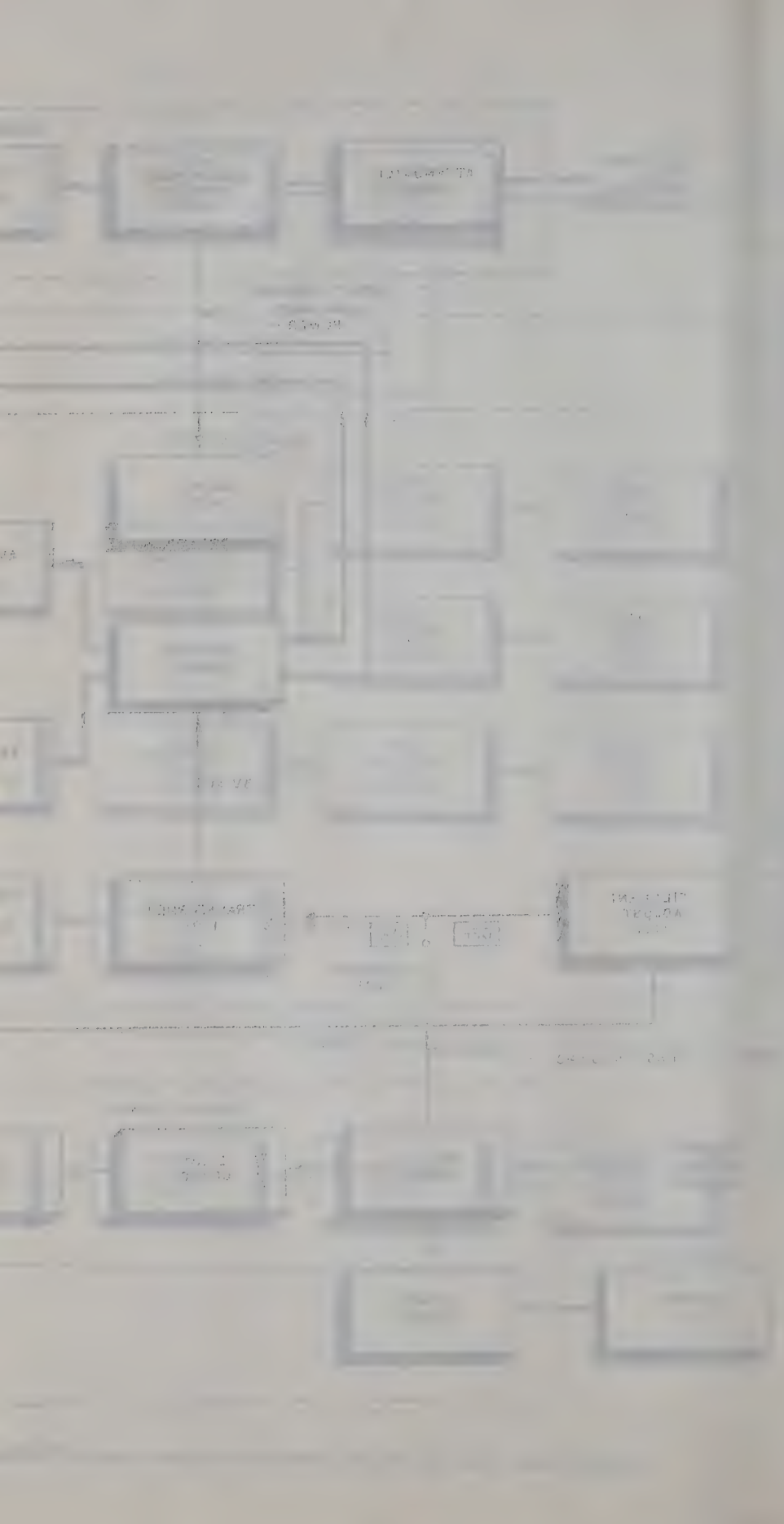


Figure 158. Radio Frequency Amplifier AM-3308/TRC-80 (pa unit), block diagram.

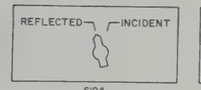



8 10 9 6 4 3 7 5
J2
REMOTE
PART OF
J101
18
22
21
14
PART OF
J209 P209
PART OF
P209 J209
6
5
13
THERMAL
INTLK
S202
AIR
INTLK
S201
1
2
PART OF
KLYSTRON DRAWER
20
19
11
12
25
29
10
6
2
5
4
3
26
28
TM5820-469-30-25 (1)

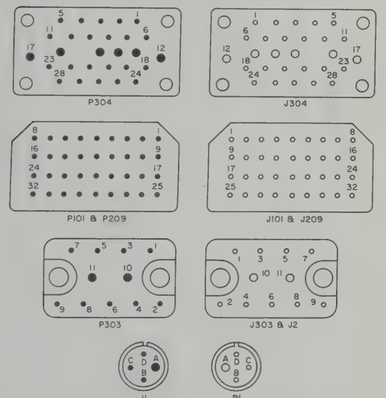


NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN HENRIES
2. ALL COMPONENTS NOT ENCLOSED BY SUBCHASSIS SYMBOL ARE PART OF THE CABINET
3. DIODES CR303–CR308 ARE TYPE GE4JA2IEX55
4. CONTACTS OF S303 OPEN WHEN DRAWER LOCK HANDLES ARE TURNED PRIOR TO REMOVING DRAWER
5. [ ] INDICATES EQUIPMENT MARKING
6. ALL WAFER SWITCHES ARE VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
7. SWITCH POSITIONS OF SI04, SI05 AND S302



8. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



9. WHEN P/N 974 0874 00 IS USED FOR K104, CONTACTS 2&3 DO NOT APPEAR

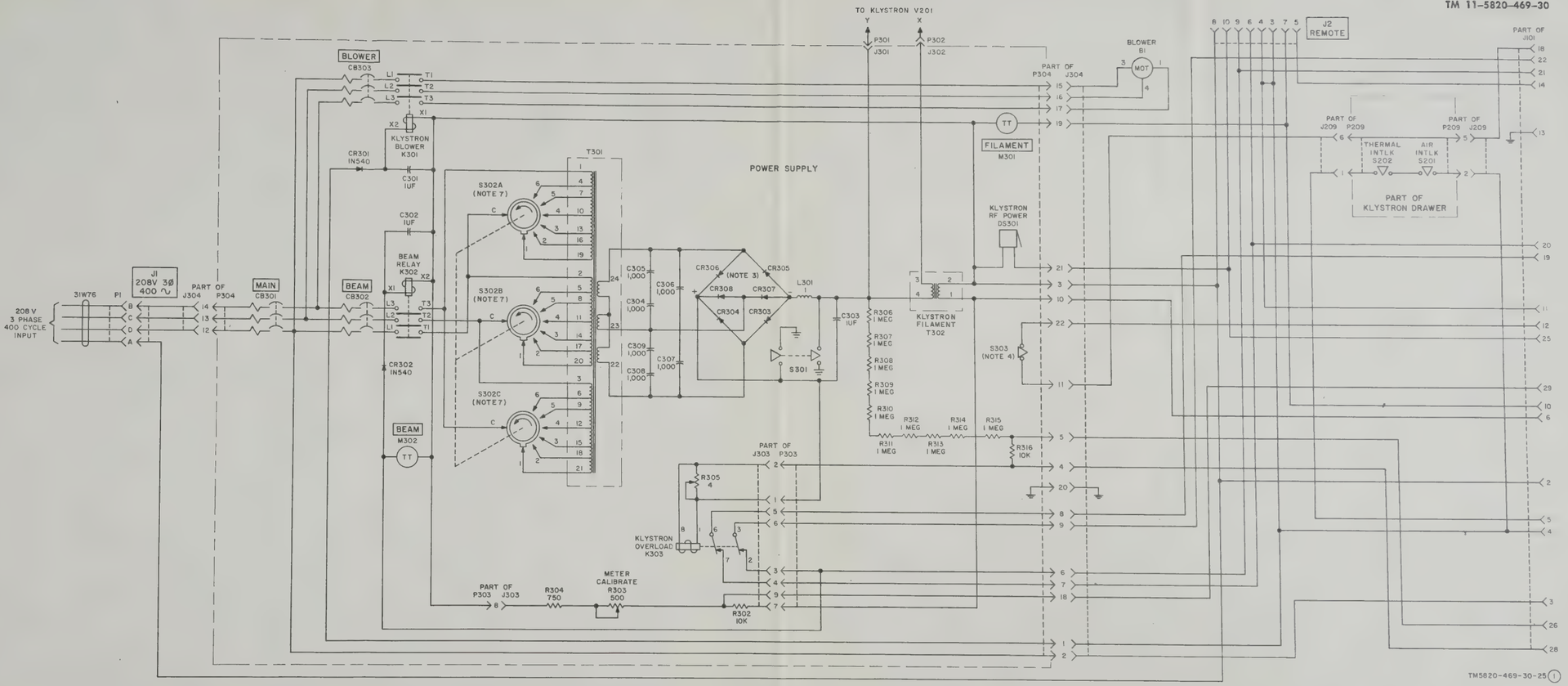
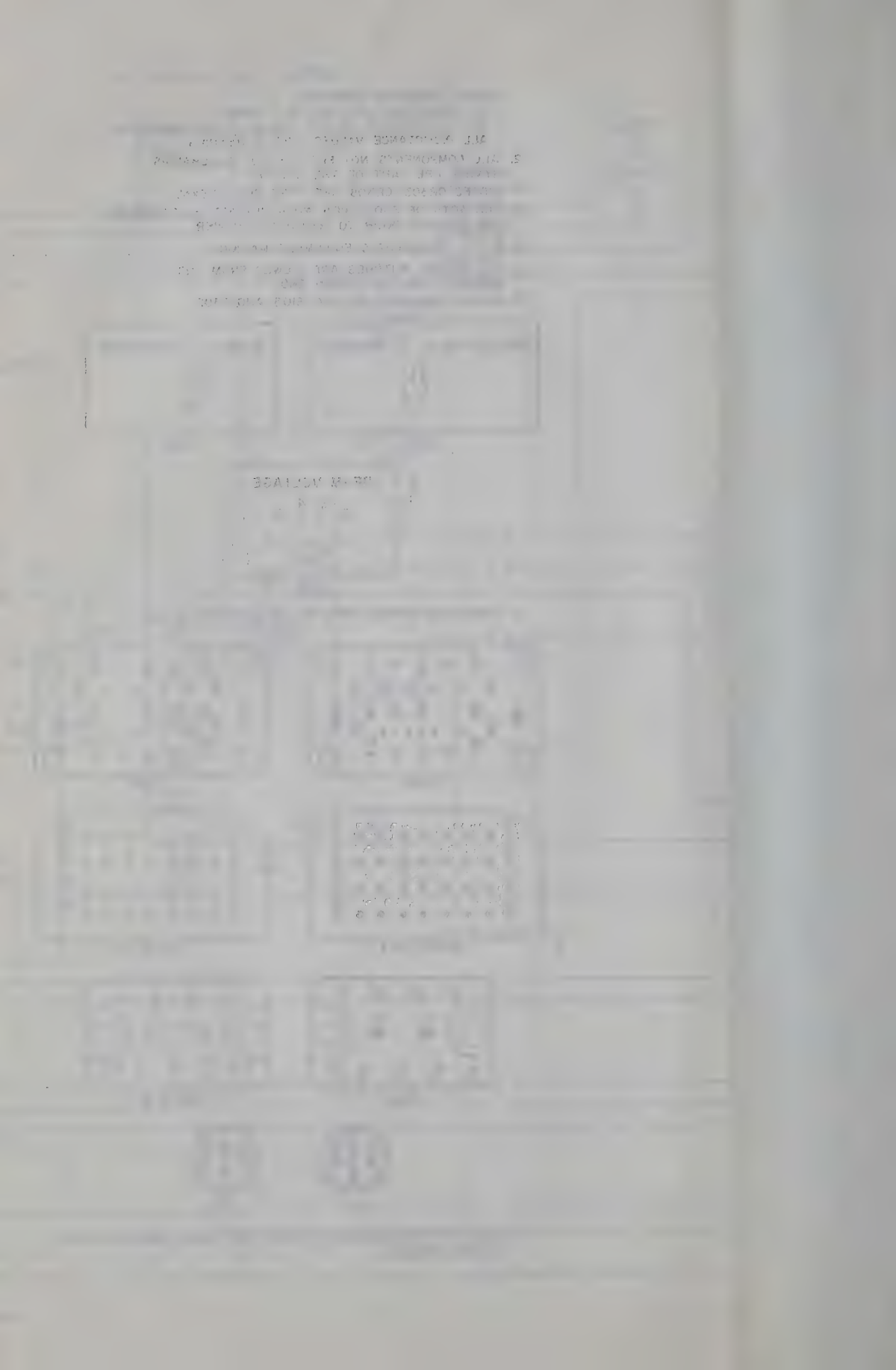
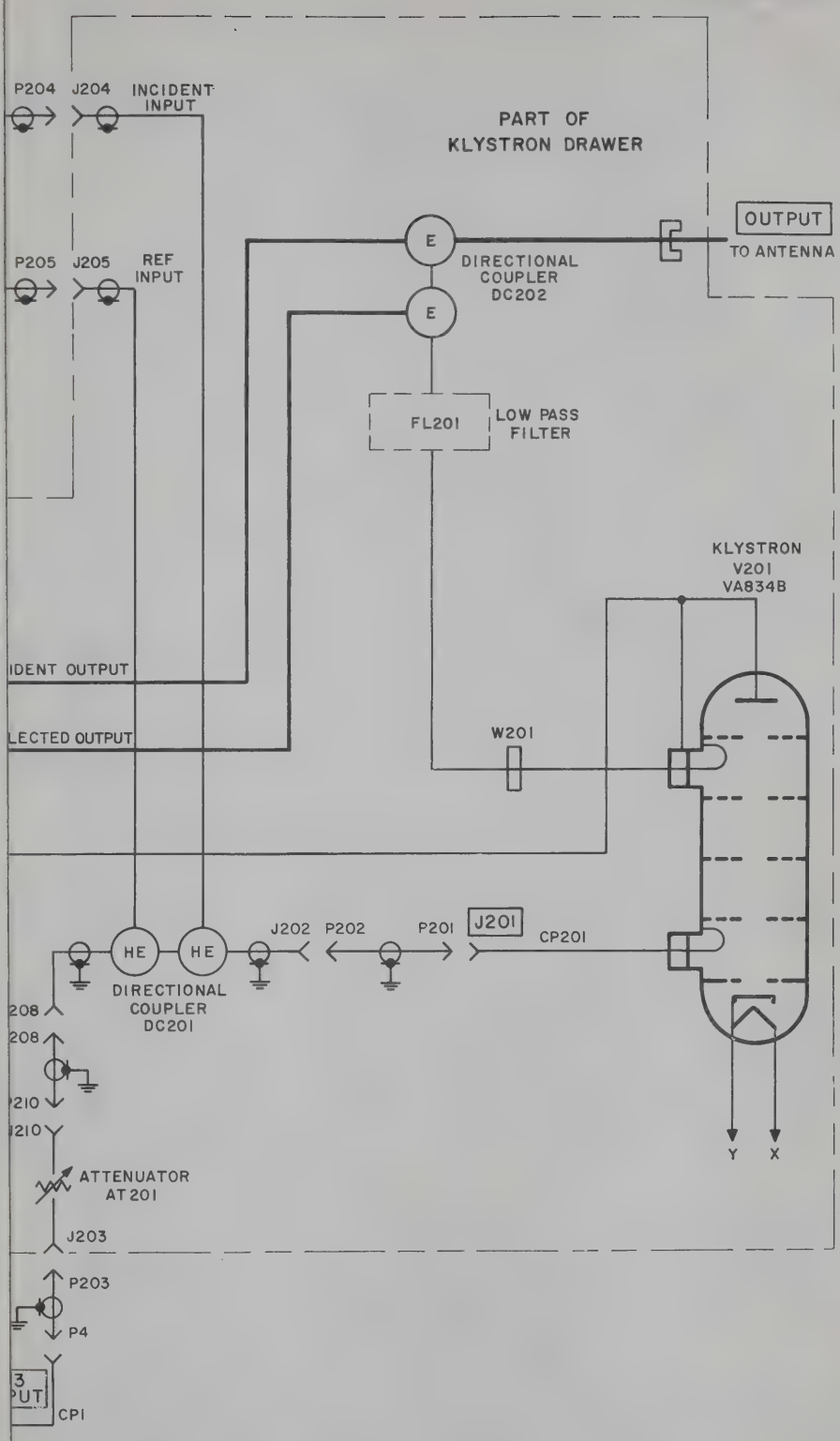
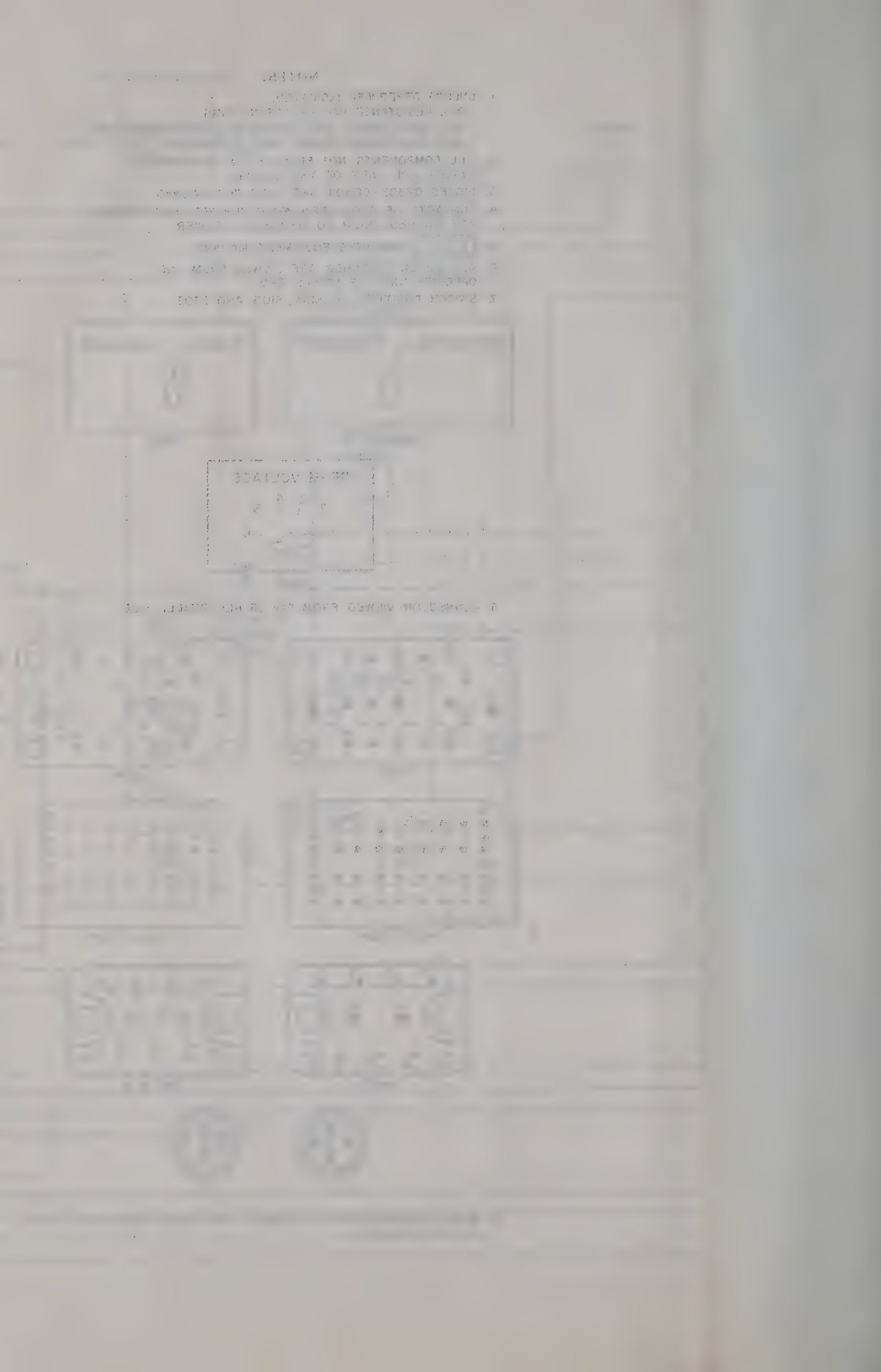
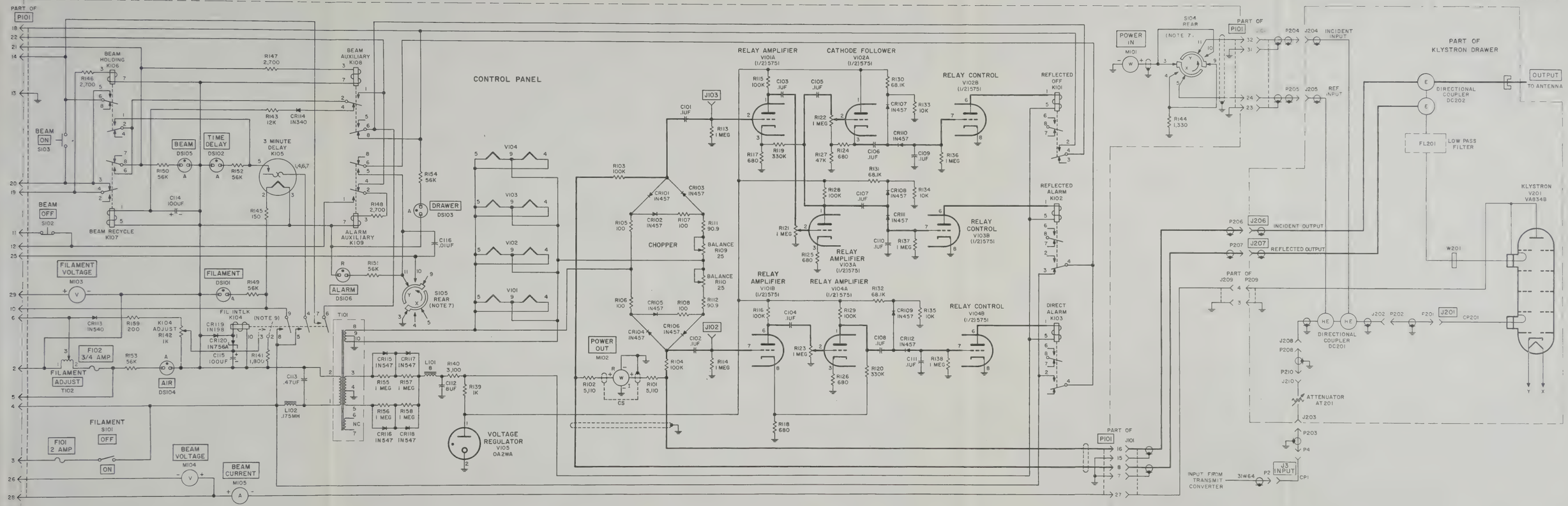


Figure 159. Radio Frequency Amplifier AM-3308/TRC-80, complete schematic diagram (part 1 of 2).



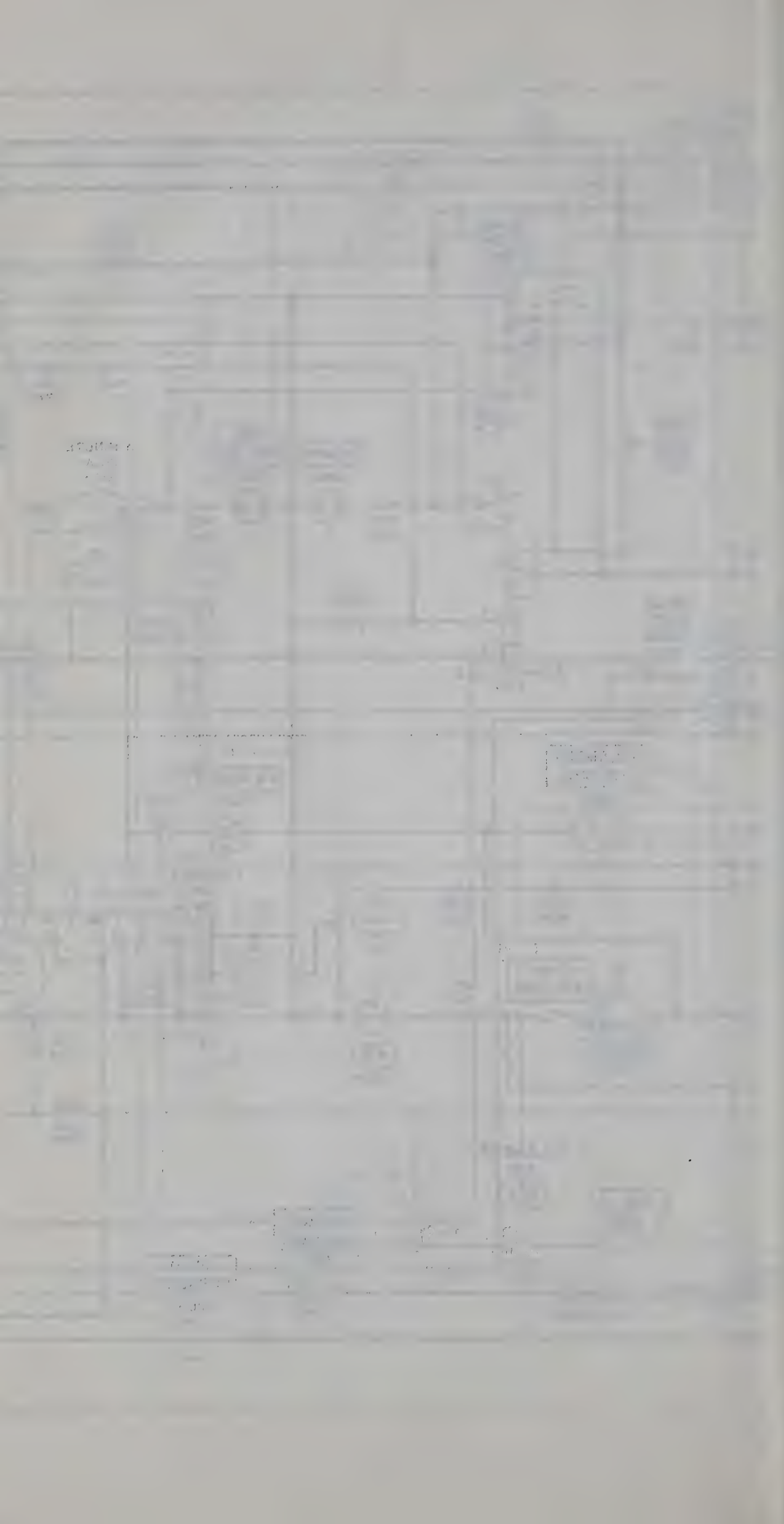

P204
J204
INCIDENT INPUT
PART OF KLYSTRON DRAWER
OUTPUT
TO ANTENNA
P205
J205
REF INPUT
E
E
DIRECTIONAL COUPLER DC202
FL201
LOW PASS FILTER
KLYSTRON V201 VA834B
IDENT OUTPUT
LECTED OUTPUT
W201
J202
P202
P201
J201
CP201
HE
HE
DIRECTIONAL COUPLER DC201
208
208
210
J210
ATTENUATOR AT201
J203
P203
P4
CP1
Y
X

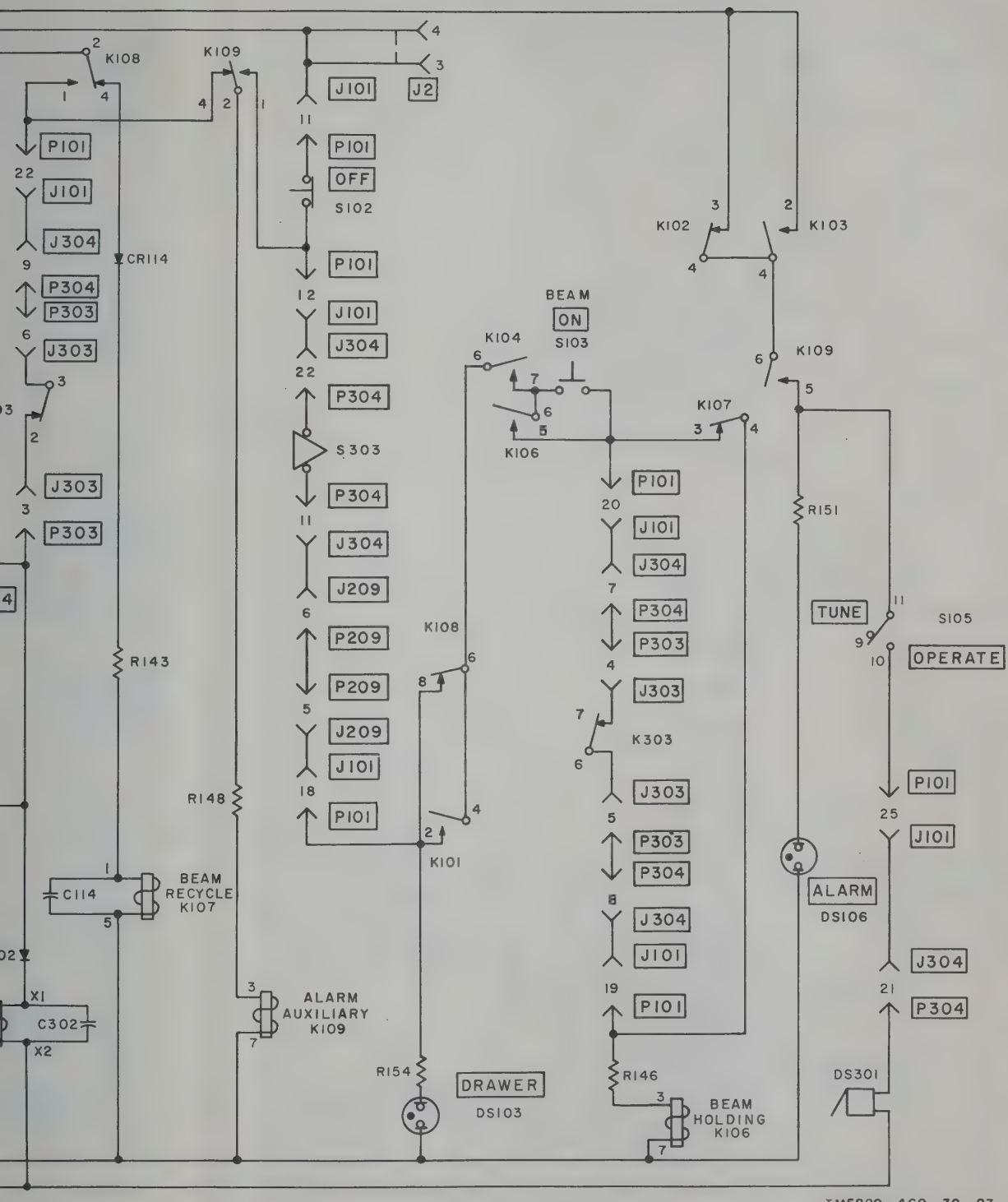




TM5820-469-30-25 (2)

Figure 159. Radio Frequency Amplifier AM-3308/TRC-80, complete schematic diagram (part 2 of 2).





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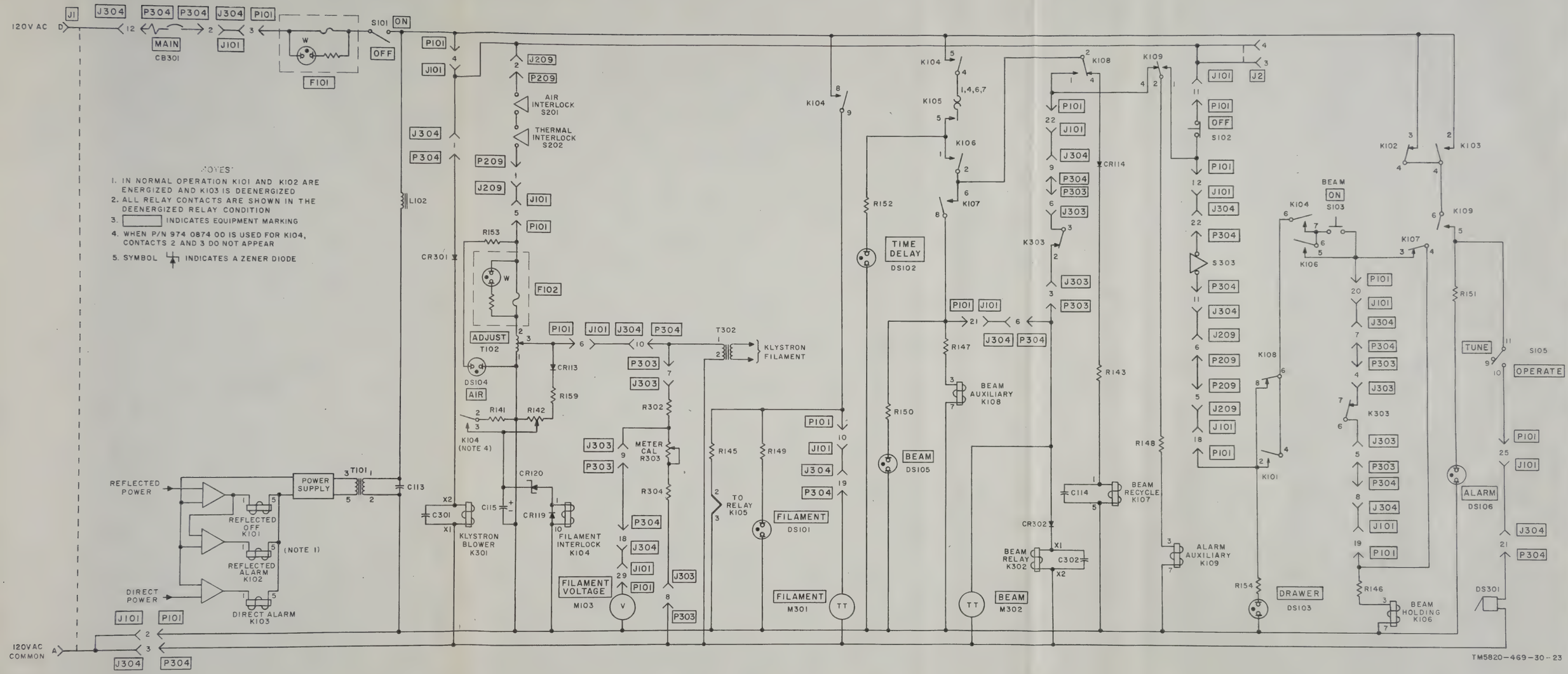
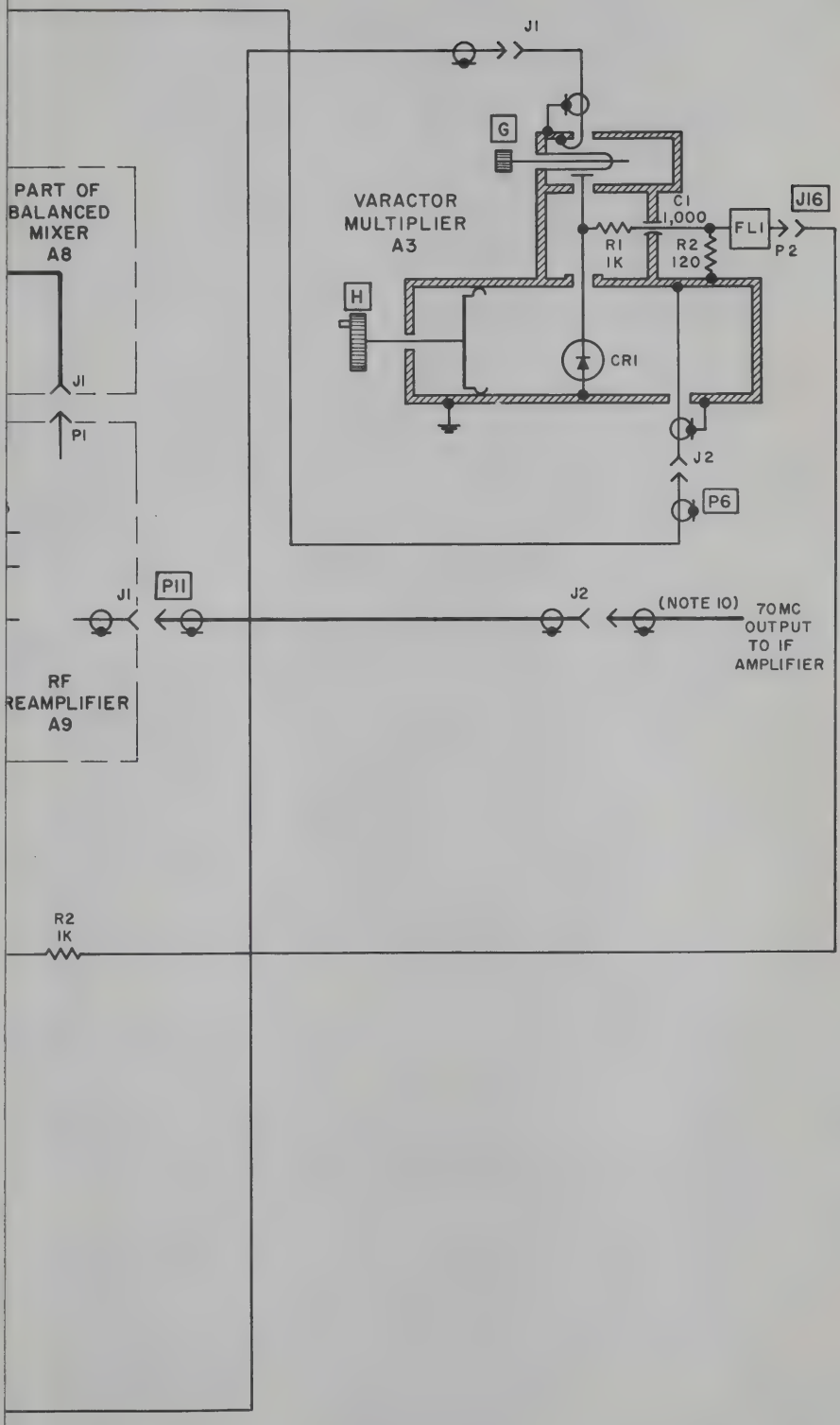
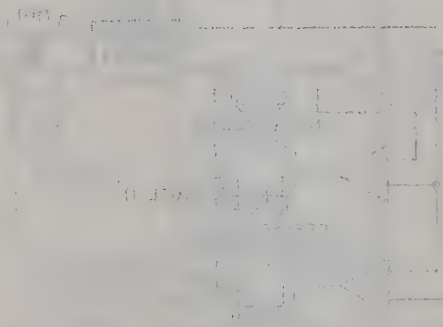


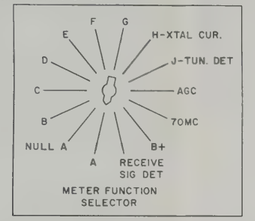
Figure 160. Radio Frequency Amplifier AM-3308/TRC-80, power control circuits, functional diagram.



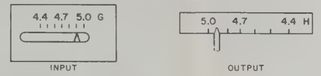
TM5820-469-30-42



NOTES
1. UNLESS OTHERWISE INDICATED,
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. SYMBOL (AC) INDICATES VARIABLE CAPACITANCE DIODE
3. ▭ INDICATES EQUIPMENT MARKING
4. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE THE KNOB OR DRIVEN END
5. SWITCH POSITIONS OF S1:

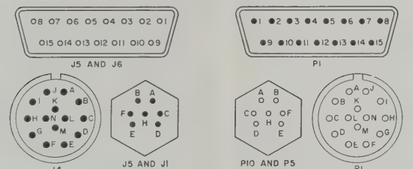


6. VARACTOR MULTIPLIER FREQUENCY ADJUST.



7. PRESELECTOR INPUT FREQUENCY ADJUST:

8. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



9. CABLE CONNECTIONS FOR J3

RACK	CABLE
A6	W24
A7	W19

10. CABLE CONNECTIONS FOR J3

RACK	CABLE
A6	W23
A7	W18

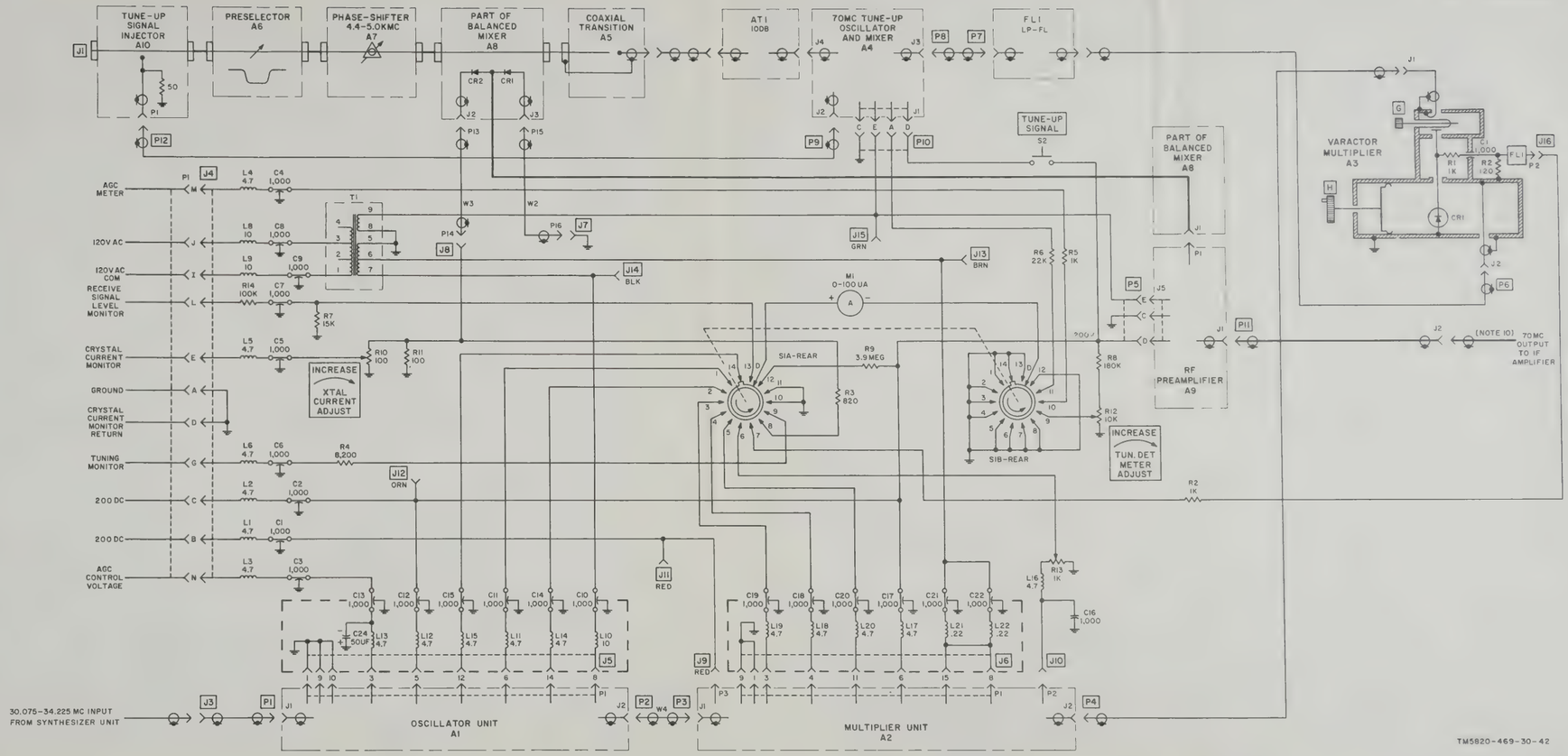
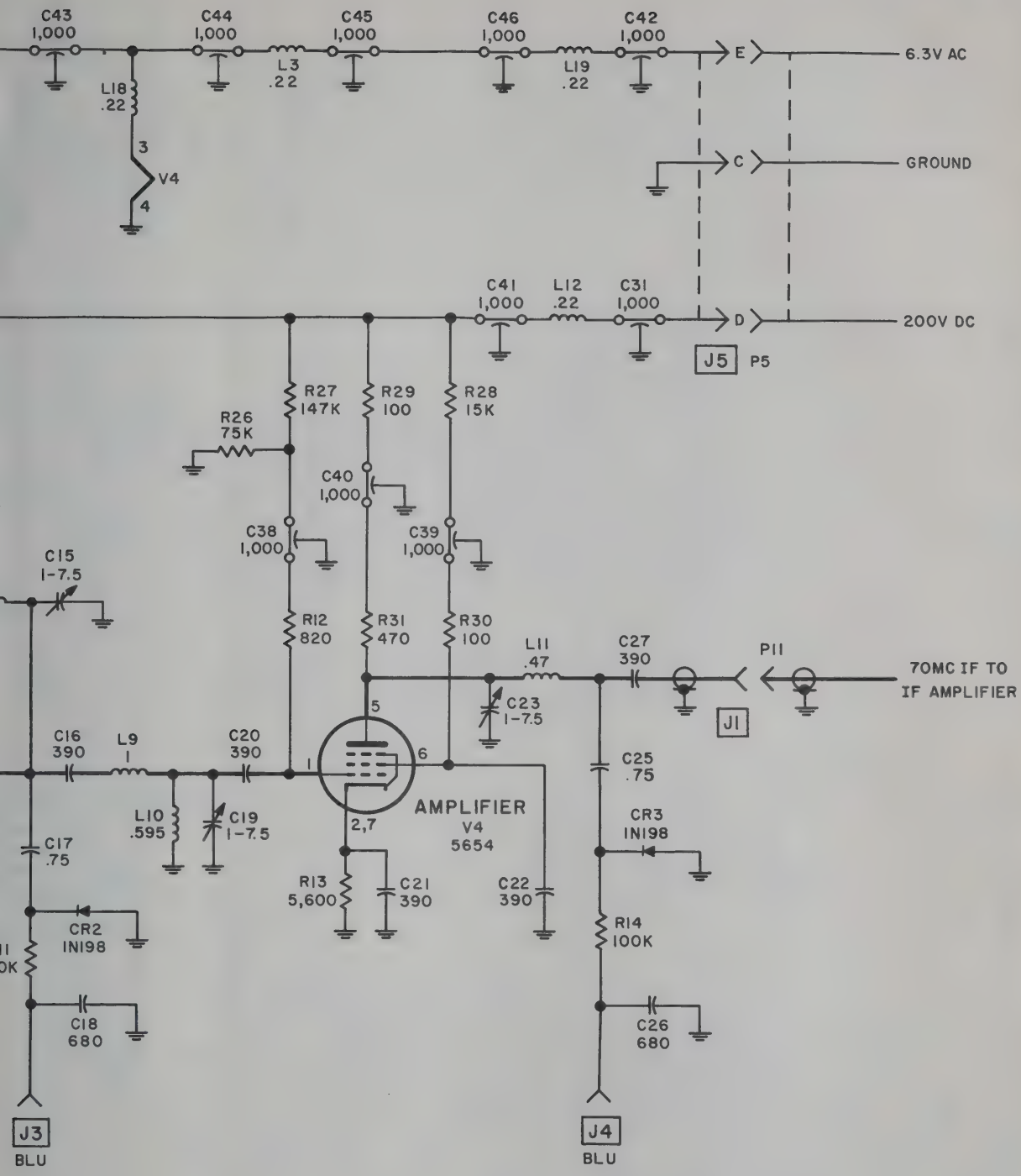


Figure 161. Amplifier-Converter AM-3302/TRC-80, schematic diagram.


C43 1,000
C44 1,000
L3 .22
C45 1,000
C46 1,000
L19 .22
C42 1,000
E
6.3V AC
L18 .22
3
V4
4
C
GROUND
C41 1,000
L12 .22
C31 1,000
D
200V DC
J5
P5
R27 147K
R29 100
R28 15K
R26 75K
C40 1,000
C38 1,000
C39 1,000
C15 1-7.5
R12 820
R31 470
R30 100
L11 .47
C27 390
P11
70MC IF TO IF AMPLIFIER
J1
C23 1-7.5
5
C16 390
L9 1
C20 390
1
6
C25 .75
L10 .595
C19 1-7.5
2,7
AMPLIFIER
V4
5654
CR3 IN198
C17 .75
R13 5,600
C21 390
C22 390
CR2 IN198
R14 100K
C18 680
C26 680
J3
BLU
J4
BLU

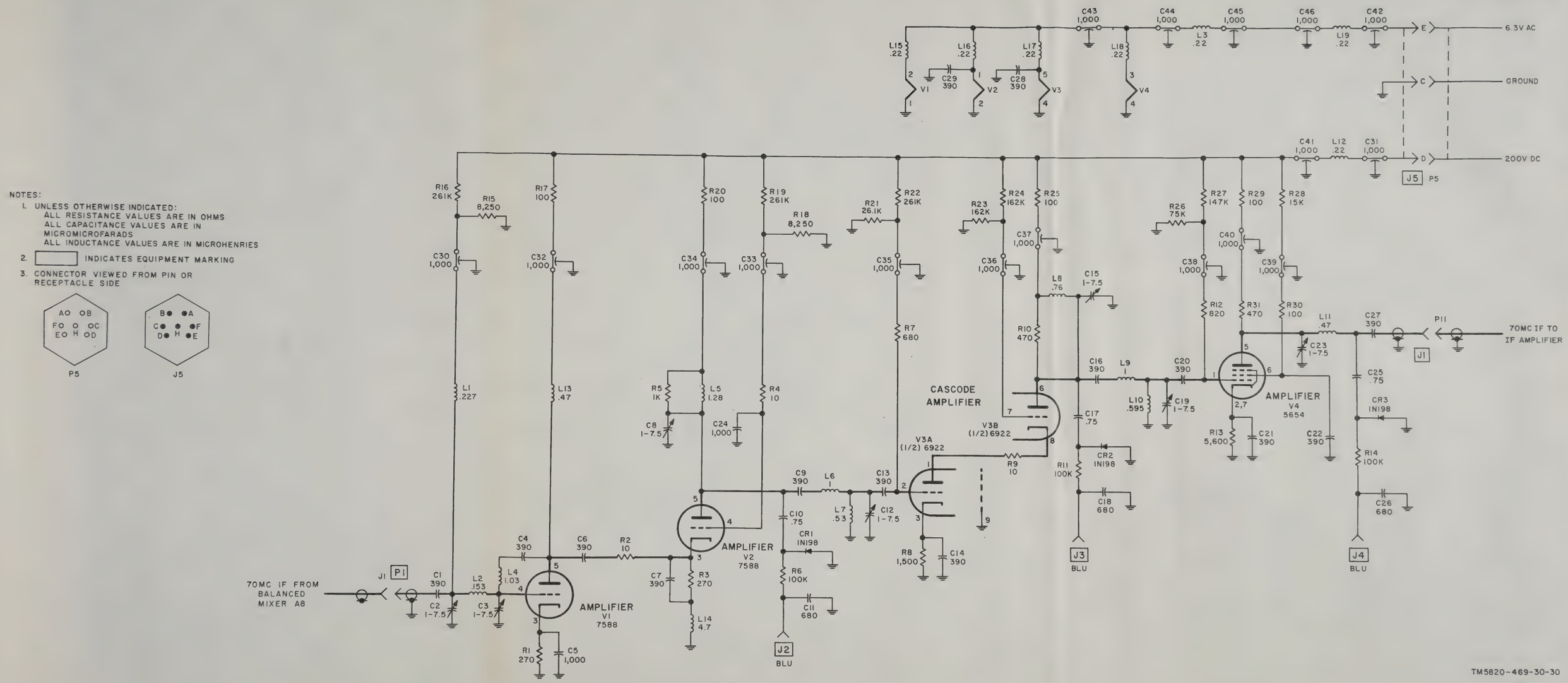


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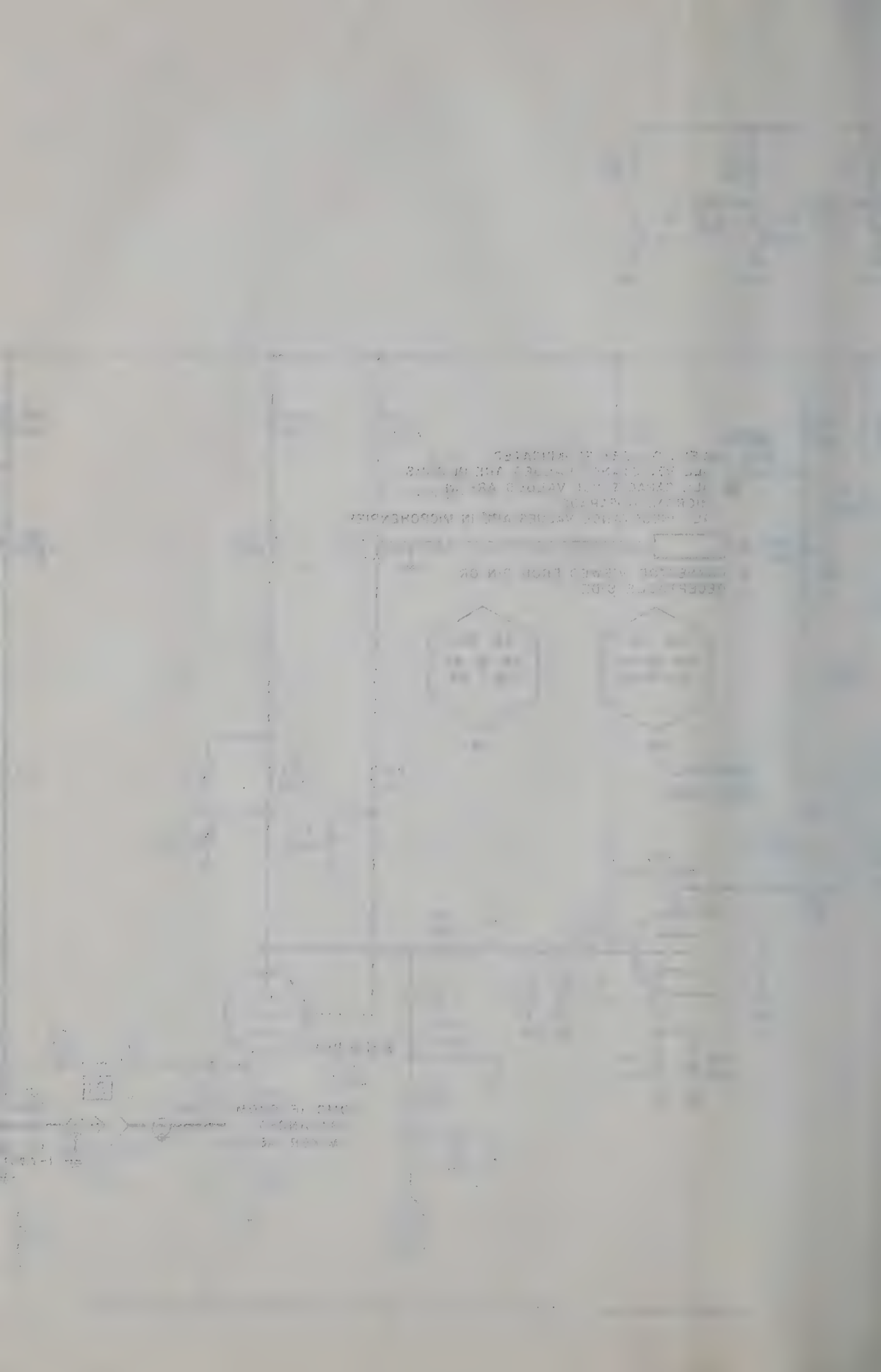
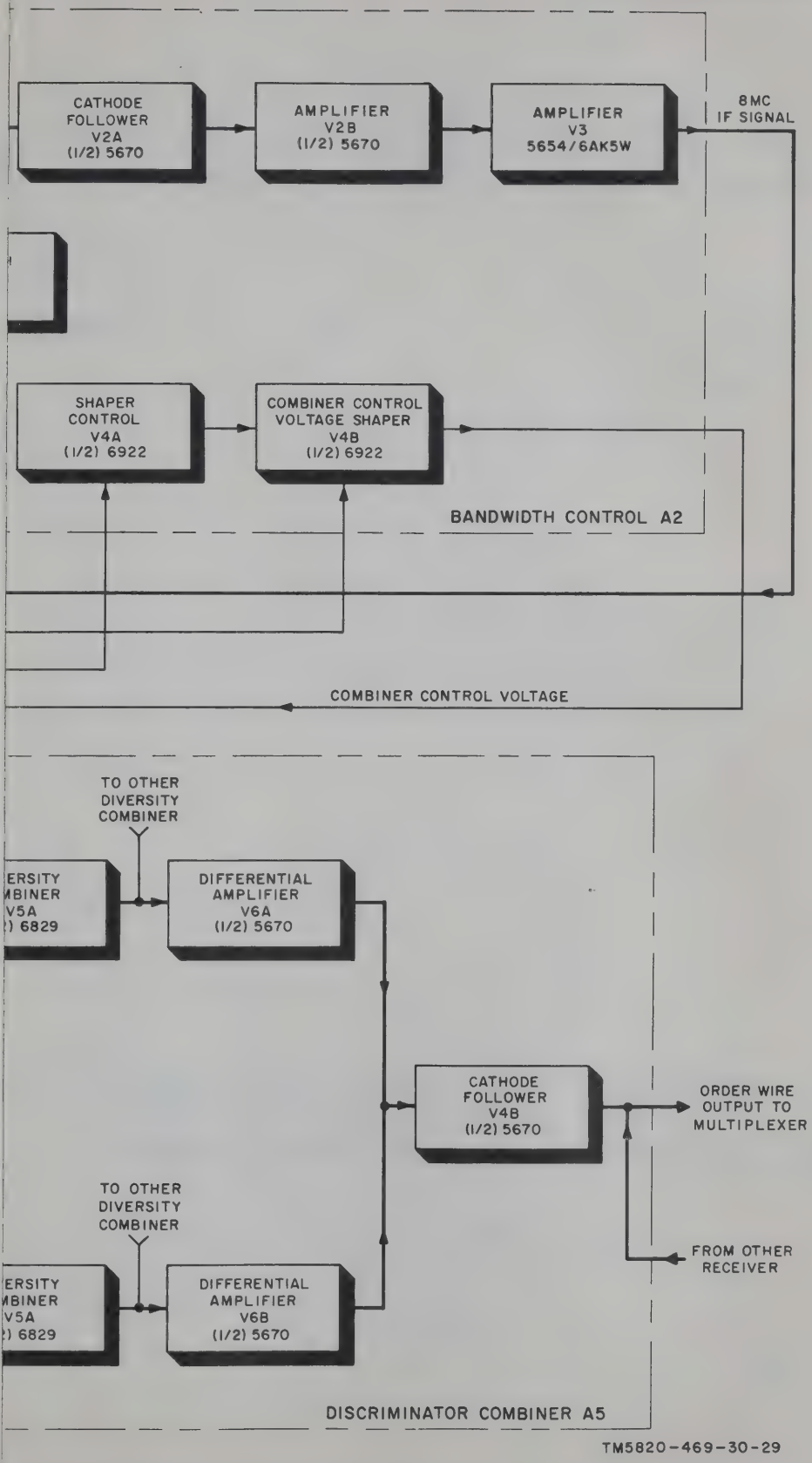
Figure 162. RF amplifier unit A9 (part of receive converter), schematic diagram.




CATHODE FOLLOWER V2A (1/2) 5670
AMPLIFIER V2B (1/2) 5670
AMPLIFIER V3 5654/6AK5W
8MC IF SIGNAL
SHAPER CONTROL V4A (1/2) 6922
COMBINER CONTROL VOLTAGE SHAPER V4B (1/2) 6922
BANDWIDTH CONTROL A2
COMBINER CONTROL VOLTAGE
TO OTHER DIVERSITY COMBINER
DIFFERENTIAL AMPLIFIER V6A (1/2) 5670
CATHODE FOLLOWER V4B (1/2) 5670
ORDER WIRE OUTPUT TO MULTIPLEXER
TO OTHER DIVERSITY COMBINER
FROM OTHER RECEIVER
DIFFERENTIAL AMPLIFIER V6B (1/2) 5670
DISCRIMINATOR COMBINER A5

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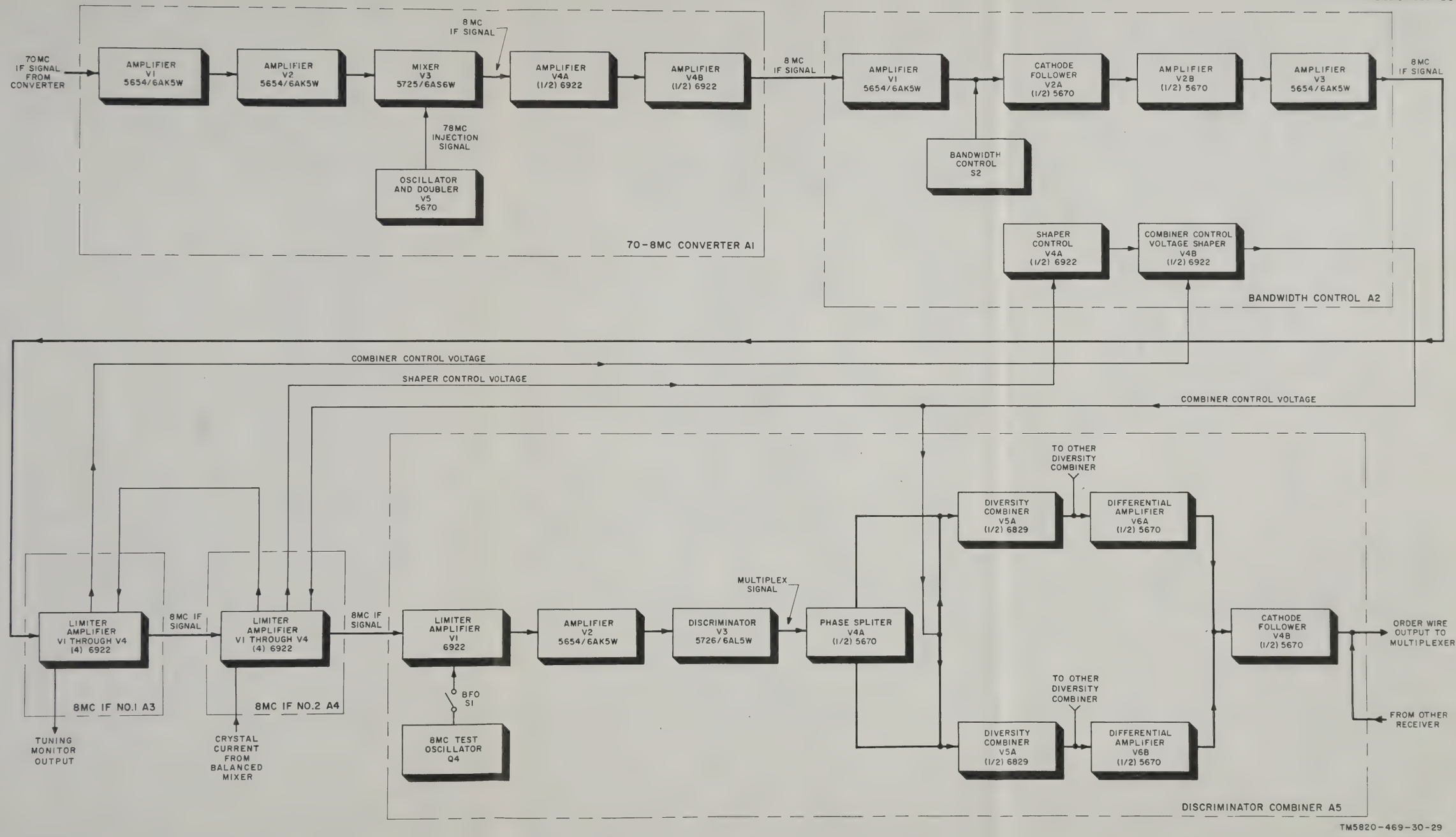
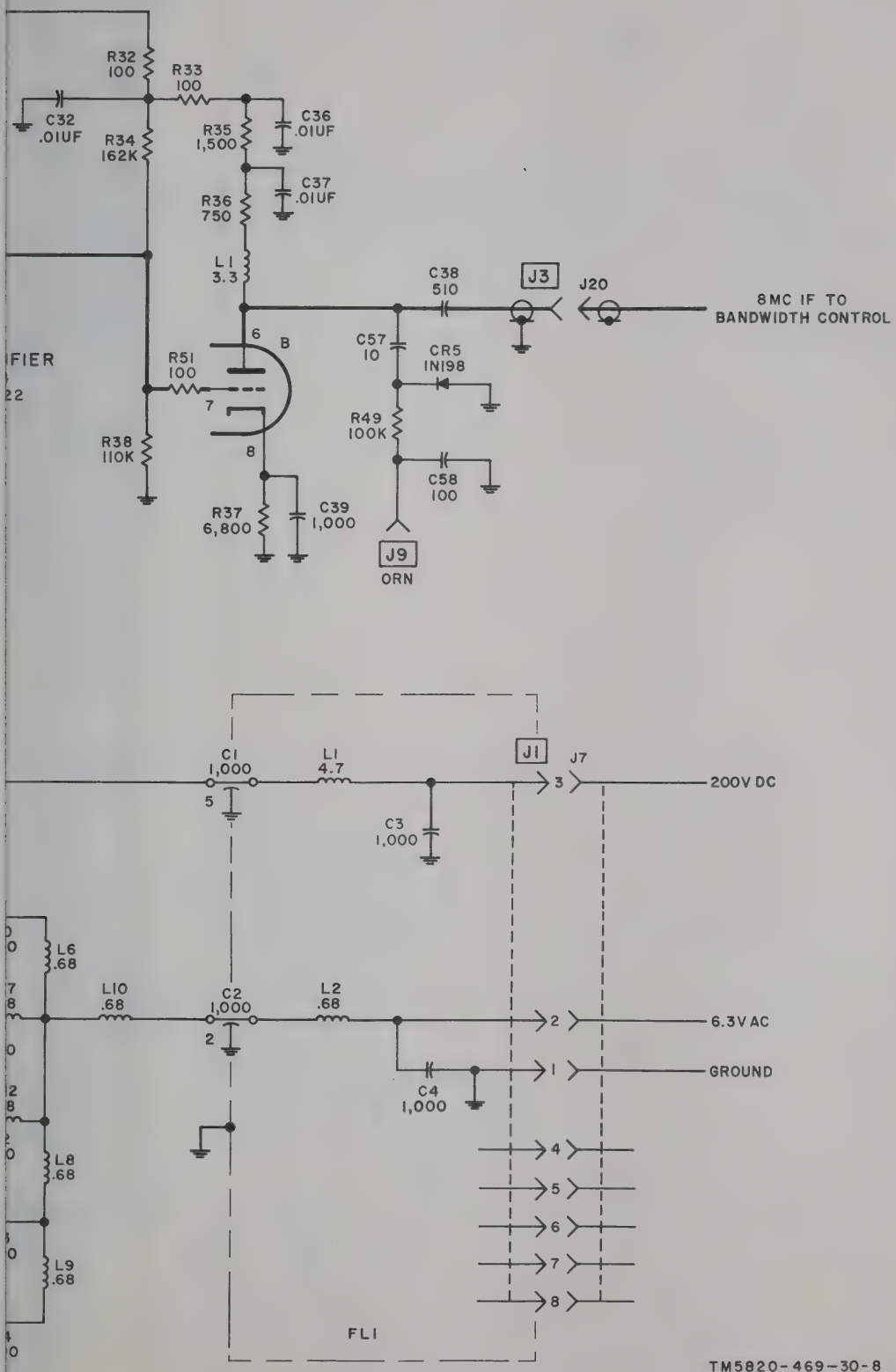
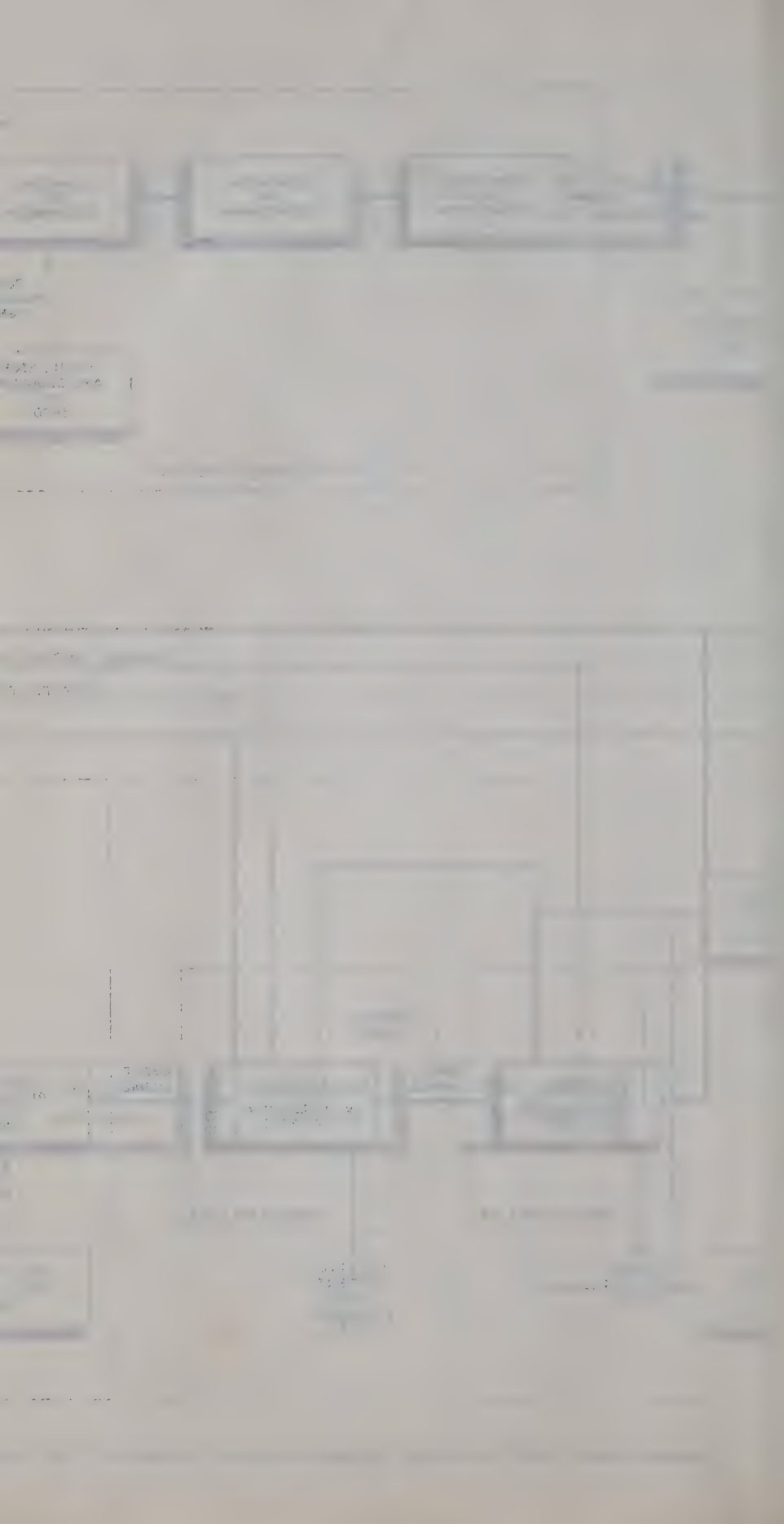


Figure 163. Intermediate Frequency Amplifier AM-3288/TRC-80, block diagram.


R32
100
R33
100
C32
.01UF
R34
162K
R35
1,500
C36
.01UF
C37
.01UF
R36
750
L1
3.3
C38
510
J3
J20
8MC IF TO
BANDWIDTH CONTROL
FIER
22
6
8
7
R51
100
C57
10
CR5
IN198
R49
100K
R38
110K
C58
100
8
R37
6,800
C39
1,000
J9
ORN
C1
1,000
L1
4.7
J1
J7
3
200V DC
5
C3
1,000
L6
.68
L10
.68
C2
1,000
L2
.68
2
6.3V AC
1
GROUND
C4
1,000
4
5
6
7
8
L8
.68
L9
.68
FL1
TM5820-469-30-8



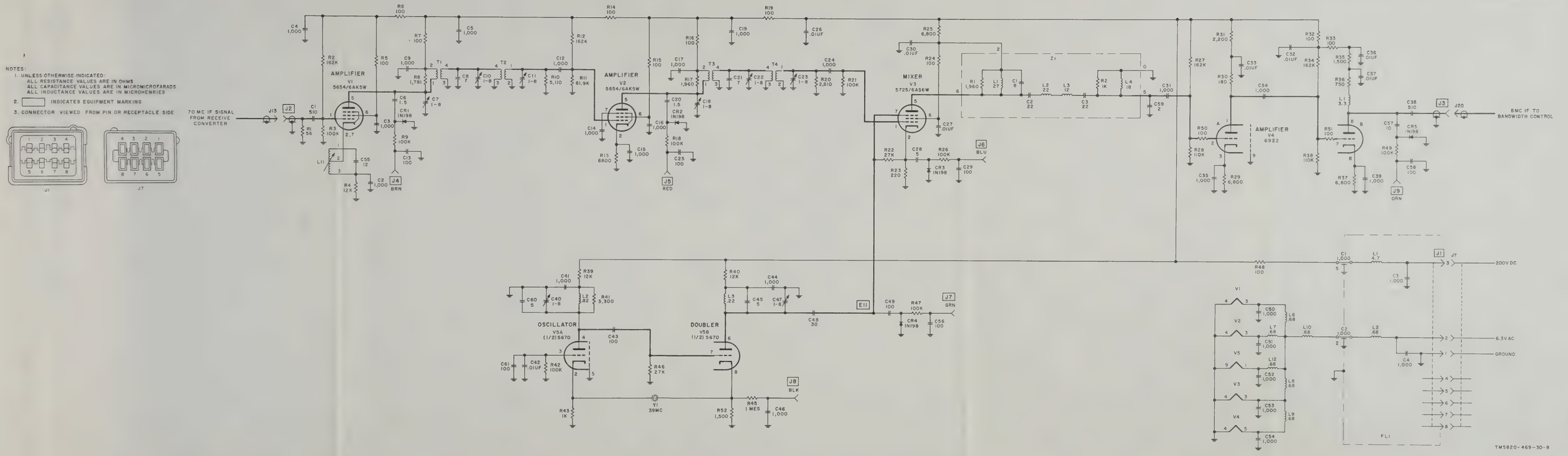
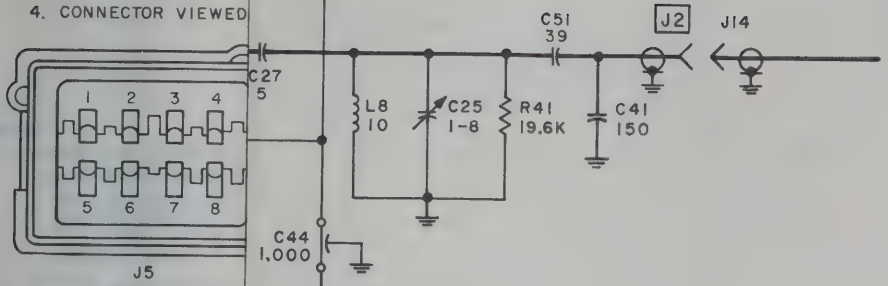
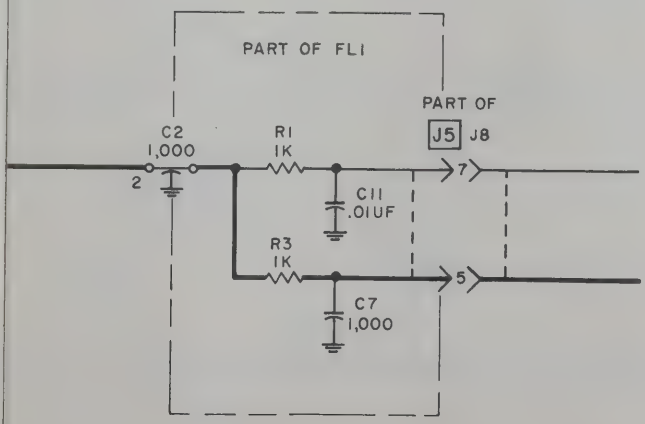


Figure 164. 70- to 8-mc converter A1 (part of IF amplifier), complete schematic diagram.

NOTES:
1. UNLESS OTHERWISE
ALL RESISTANCE
ALL CAPACITANCE
ALL INDUCTANCE
2. SYMBOL INDIC
3. INDICATES
4. CONNECTOR VIEWED



8MC IF SIGNAL TO
8 MC IF NO. 1



COMBINER CONTROL
VOLTAGE TO J12-5

COMBINER CONTROL
VOLTAGE TO METER M1
ON 8MC IF NO. 2, J4-4

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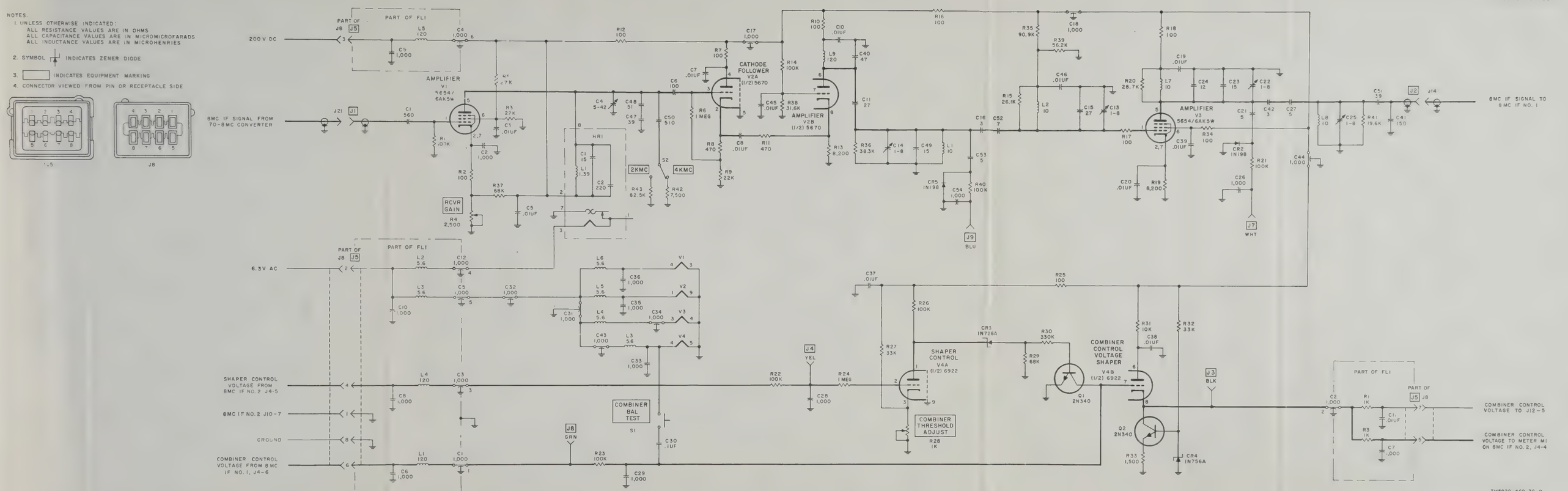
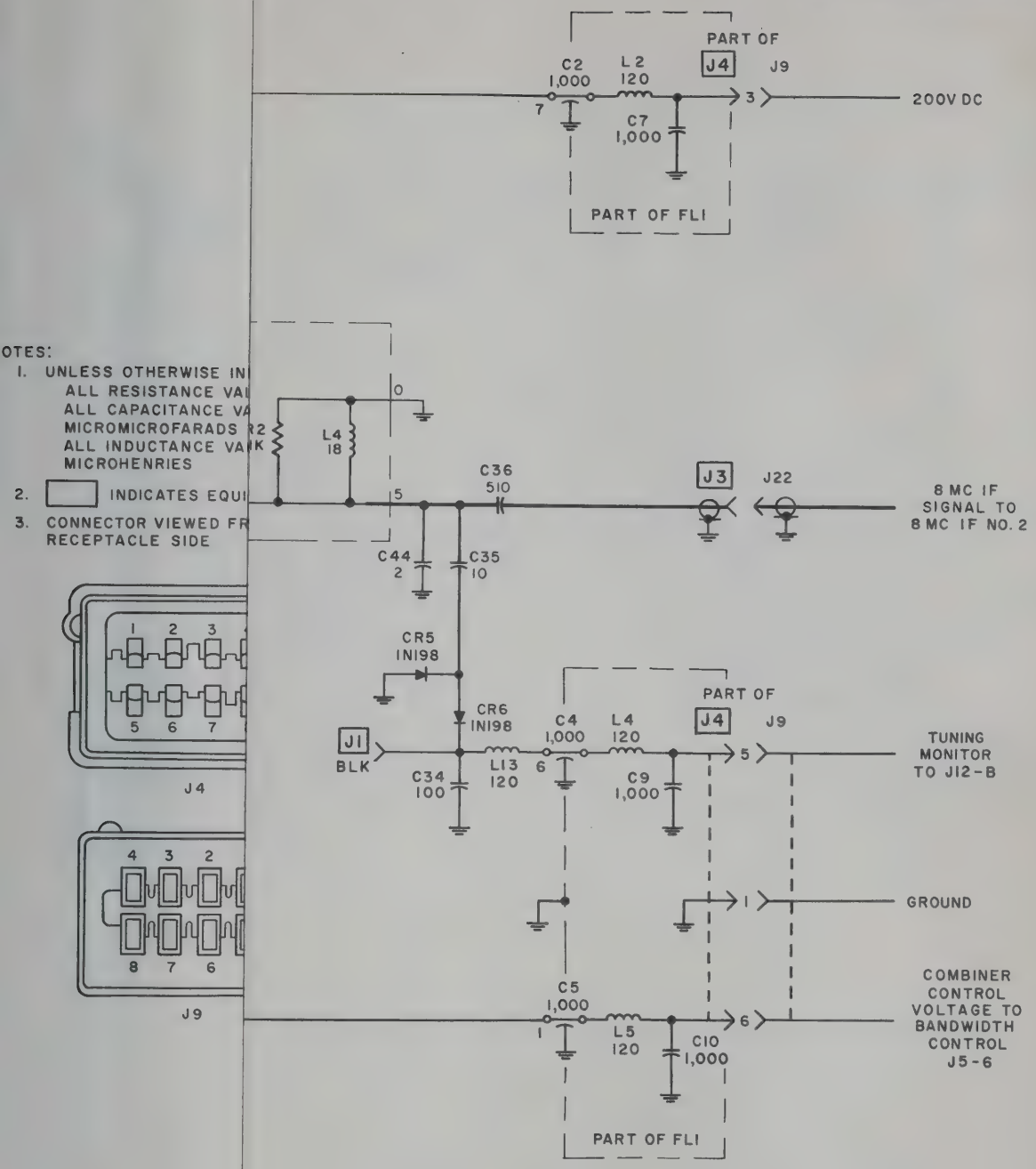
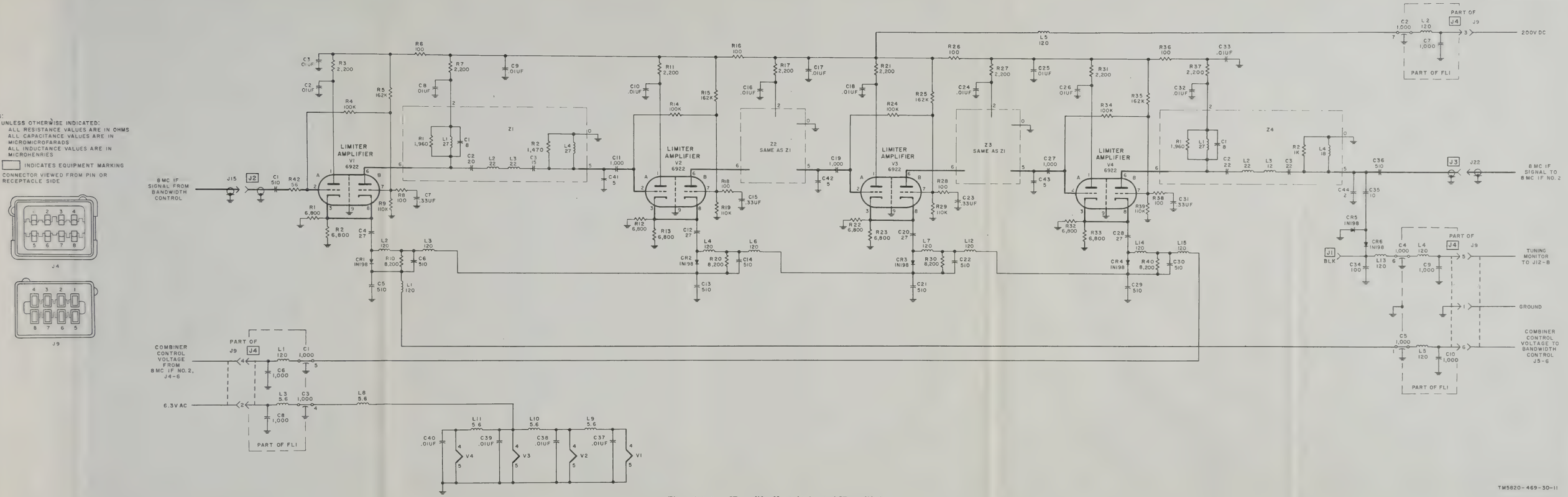

NOTES.
1. UNLESS OTHERWISE INDICATED:
ALL RESISTANCE VALUES ARE IN OHMS
ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. SYMBOL INDICATES ZENER DIODE
3. INDICATES EQUIPMENT MARKING
4. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE
J5
J8
200 V DC
8MC IF SIGNAL FROM 70-8MC CONVERTER
6.3V AC
SHAPER CONTROL VOLTAGE FROM 8MC IF NO. 2 J4-5
8MC IF NO. 2 J10-7
GROUND
COMBINER CONTROL VOLTAGE FROM 8MC IF NO. 1, J4-6
8MC IF SIGNAL TO 8MC IF NO. 1
COMBINER CONTROL VOLTAGE TO J12-5
COMBINER CONTROL VOLTAGE TO METER M1 ON 8MC IF NO. 2, J4-4
PART OF FLI
PART OF J8 J5
AMPLIFIER V1 5654/6AK5W
CATHODE FOLLOWER V2A (1/2) 5670
AMPLIFIER V2B (1/2) 5670
AMPLIFIER V3 5654/6AK5W
SHAPER CONTROL V4A (1/2) 6922
COMBINER CONTROL VOLTAGE SHAPER V4B (1/2) 6922
RCVR GAIN
2KMC
4KMC
COMBINER BAL TEST
COMBINER THRESHOLD ADJUST
J1 J2 J3 J4 J7 J8 J9 J12 J14
YEL BLK GRN BLU WHT
CR1 IN726A
CR2 IN198
CR3 IN198
CR4 IN756A
CR5 IN198
Q1 2N340
Q2 2N340
TM5820-469-30-9

Figure 165. Bandwidth control A2 (part of IF amplifier), complete schematic diagram.

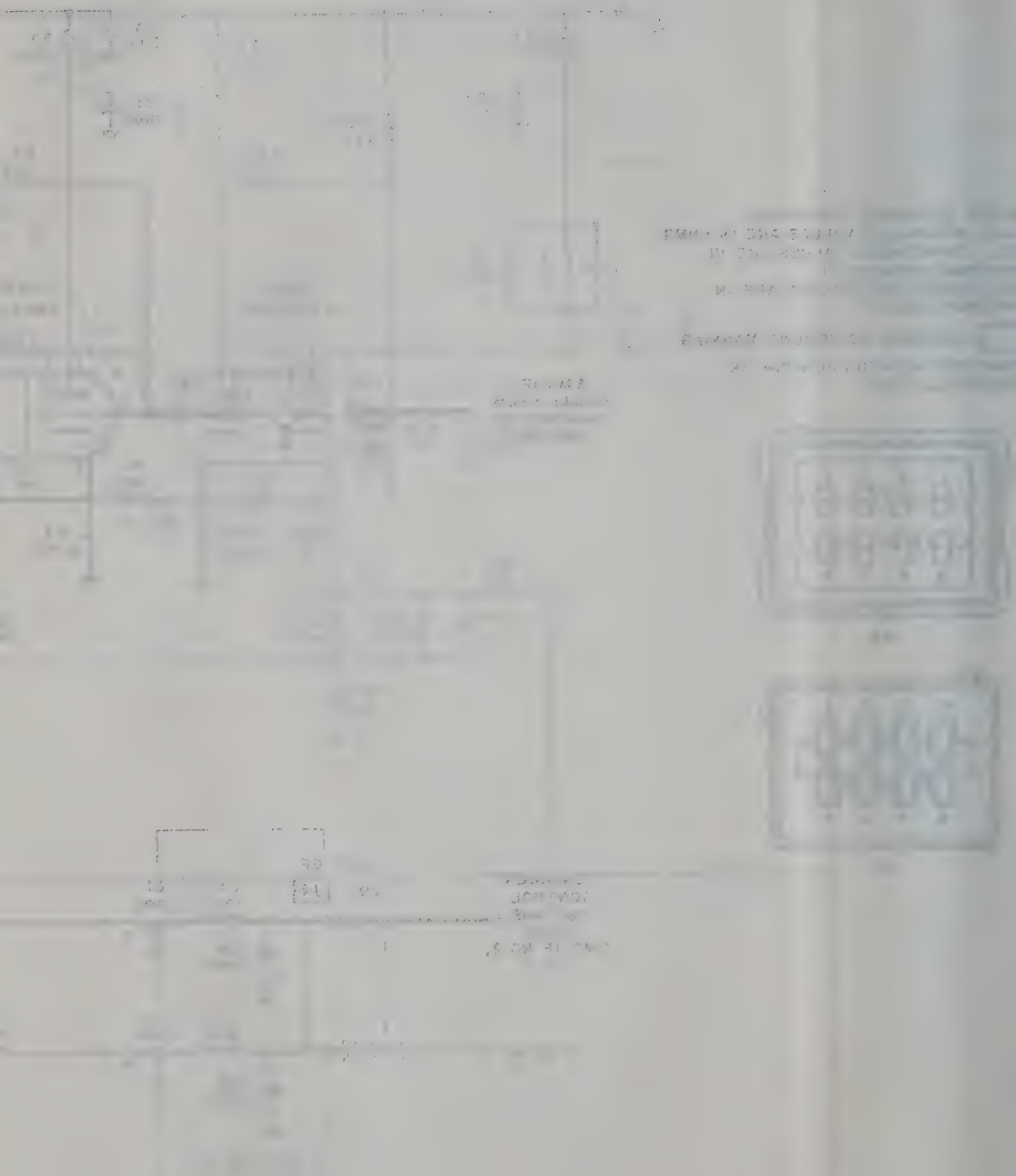


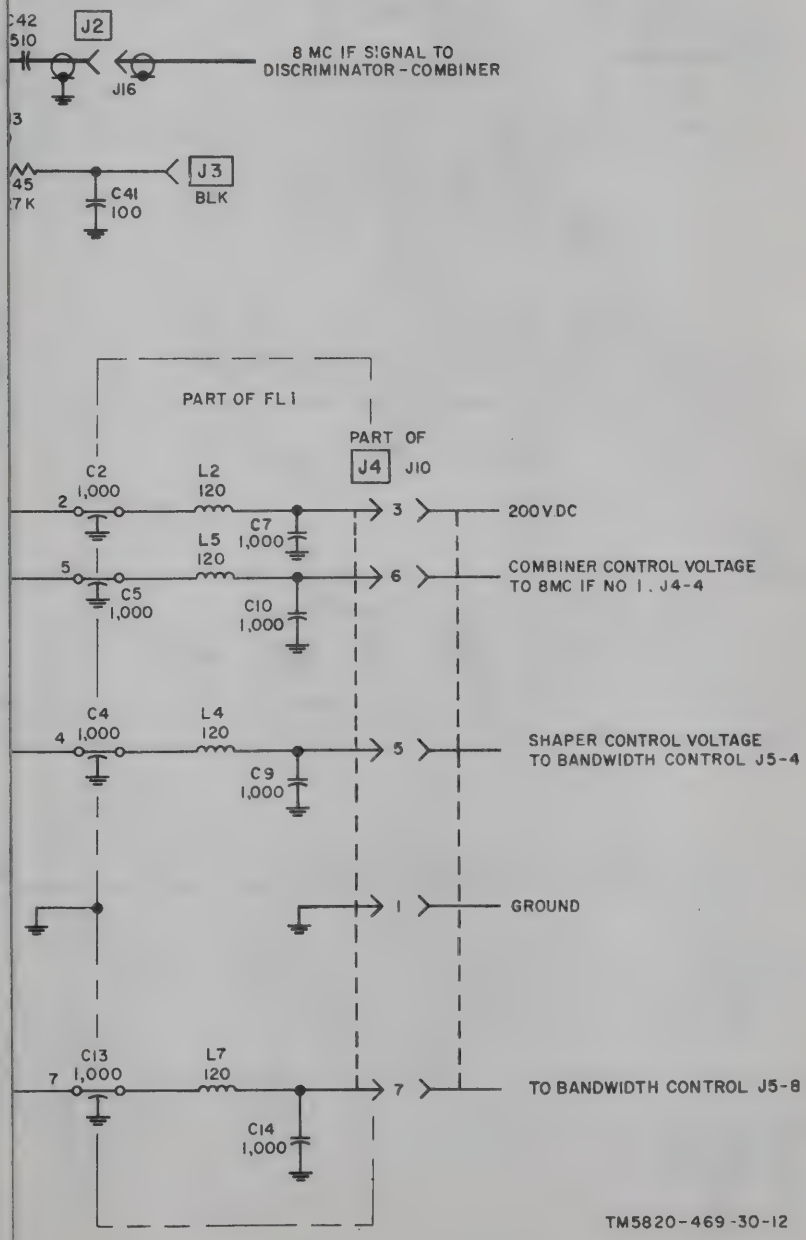
TM5820-469-30-11

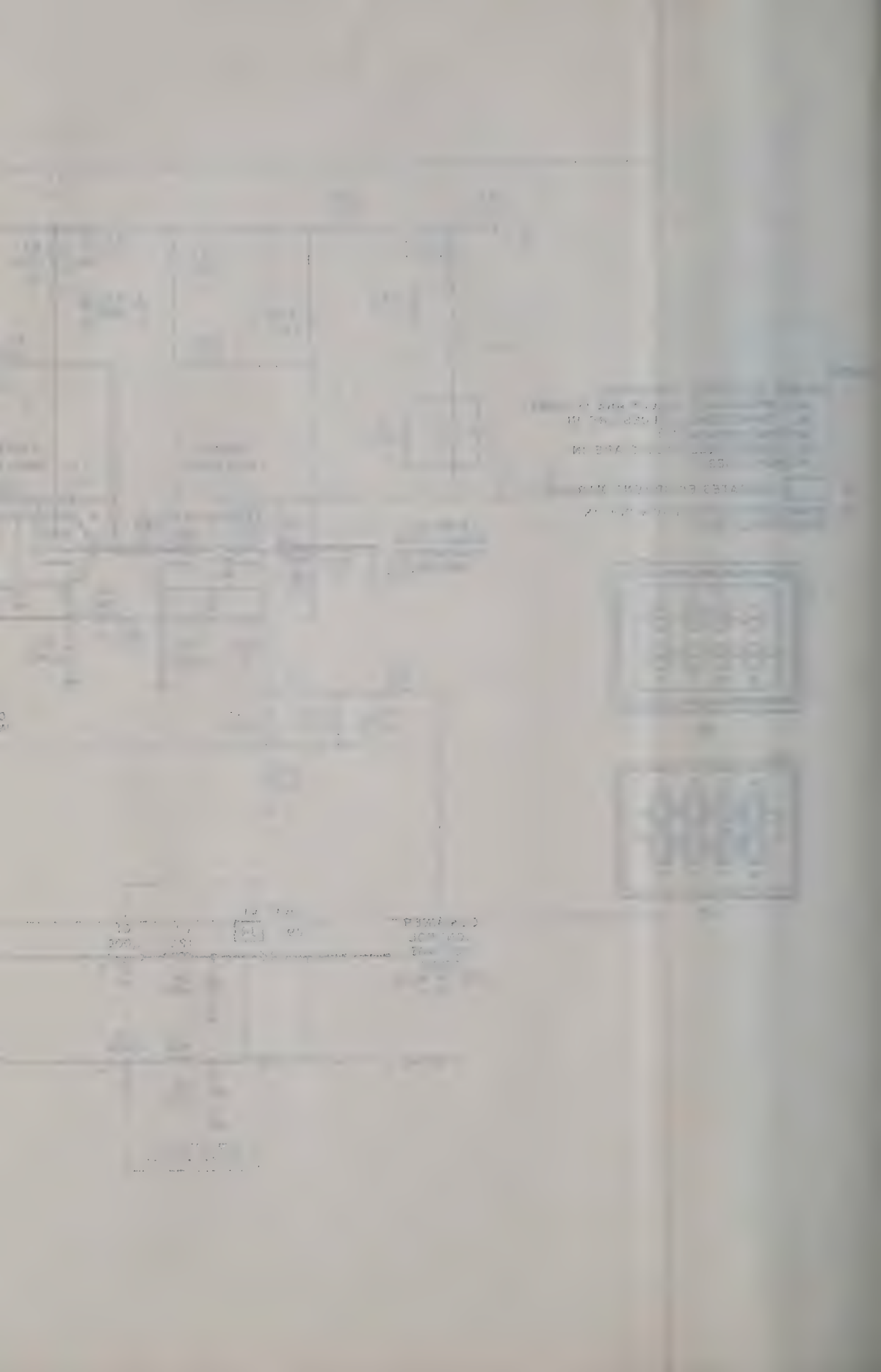


TM5820-469-30-11

Figure 166. 8-mc IF amplifier No. 1 A3 (part of IF amplifier), complete schematic diagram.




C42
510
J2
J16
8 MC IF SIGNAL TO
DISCRIMINATOR - COMBINER
3
45
7K
C41
100
J3
BLK
PART OF FL1
PART OF
J4
J10
C2
1,000
L2
120
2
3
200VDC
C7
1,000
L5
120
5
6
COMBINER CONTROL VOLTAGE
TO 8MC IF NO 1, J4-4
C5
1,000
C10
1,000
C4
1,000
L4
120
4
5
SHAPER CONTROL VOLTAGE
TO BANDWIDTH CONTROL J5-4
C9
1,000
1
GROUND
C13
1,000
L7
120
7
7
TO BANDWIDTH CONTROL J5-8
C14
1,000
TM5820-469-30-12



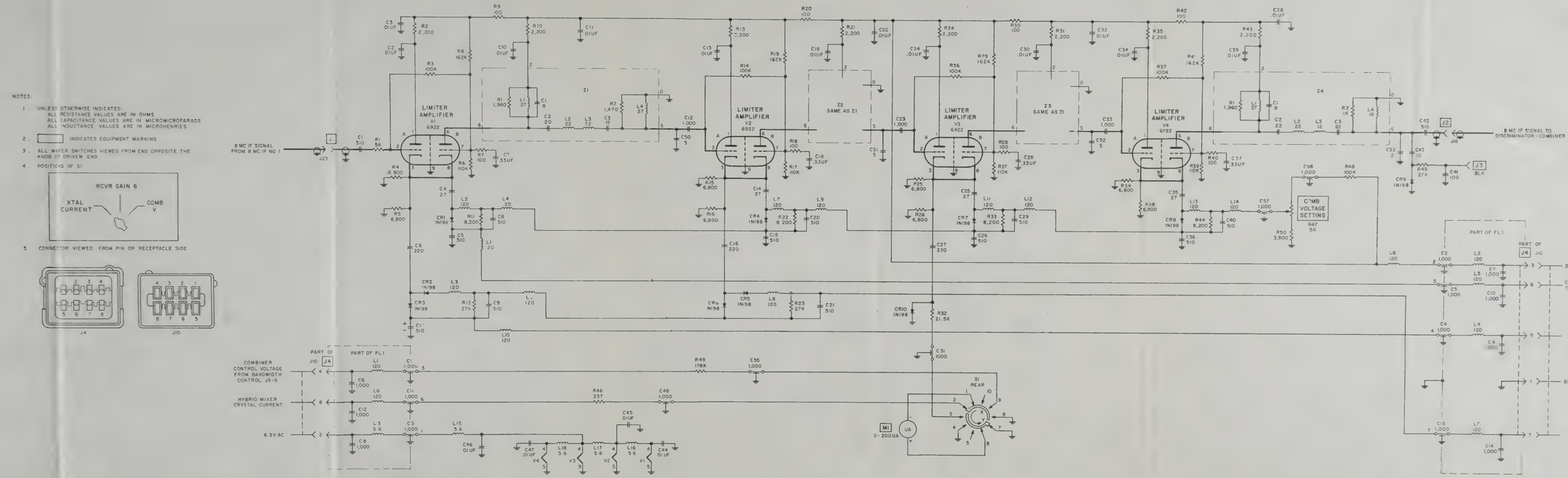
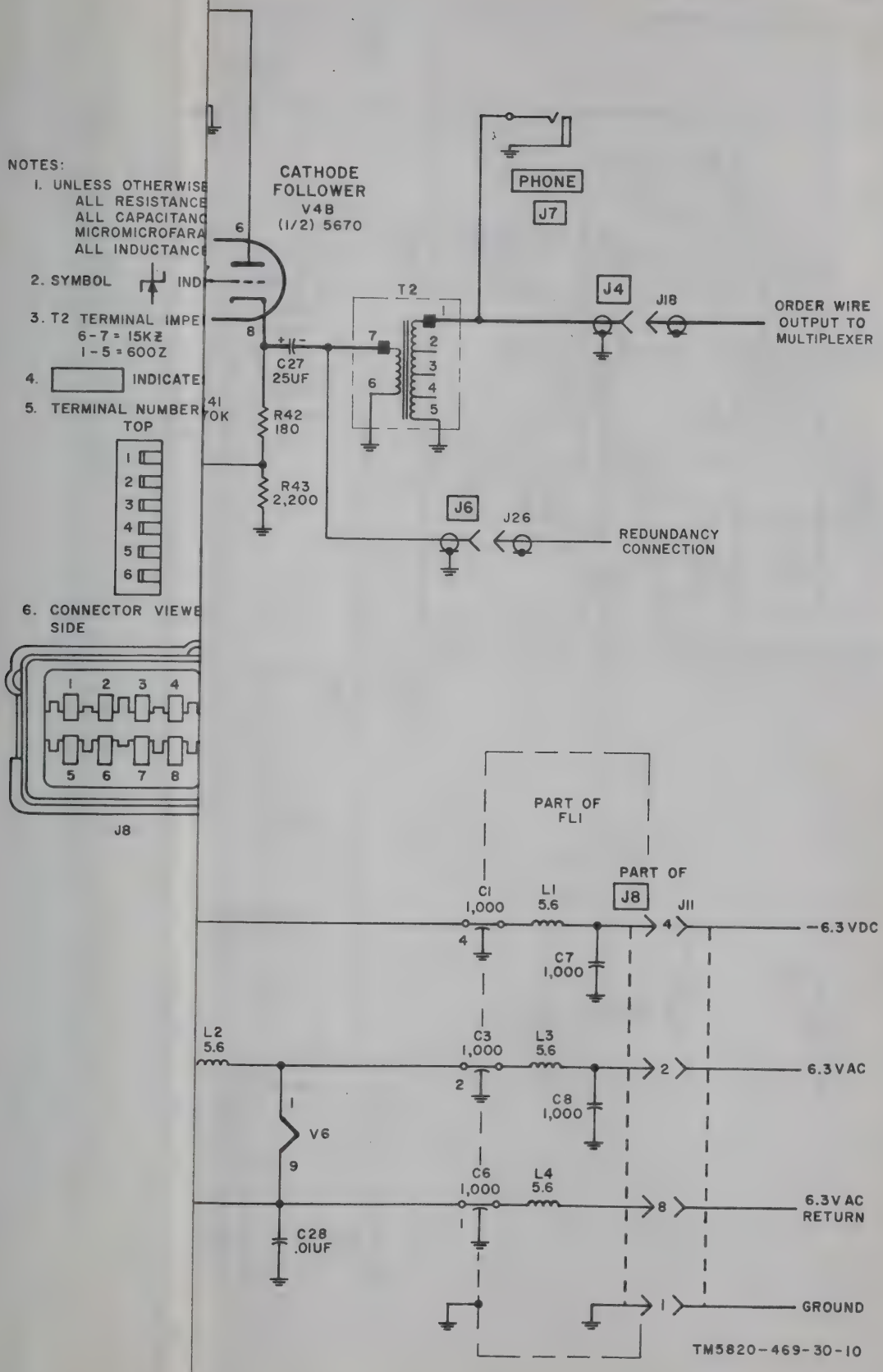
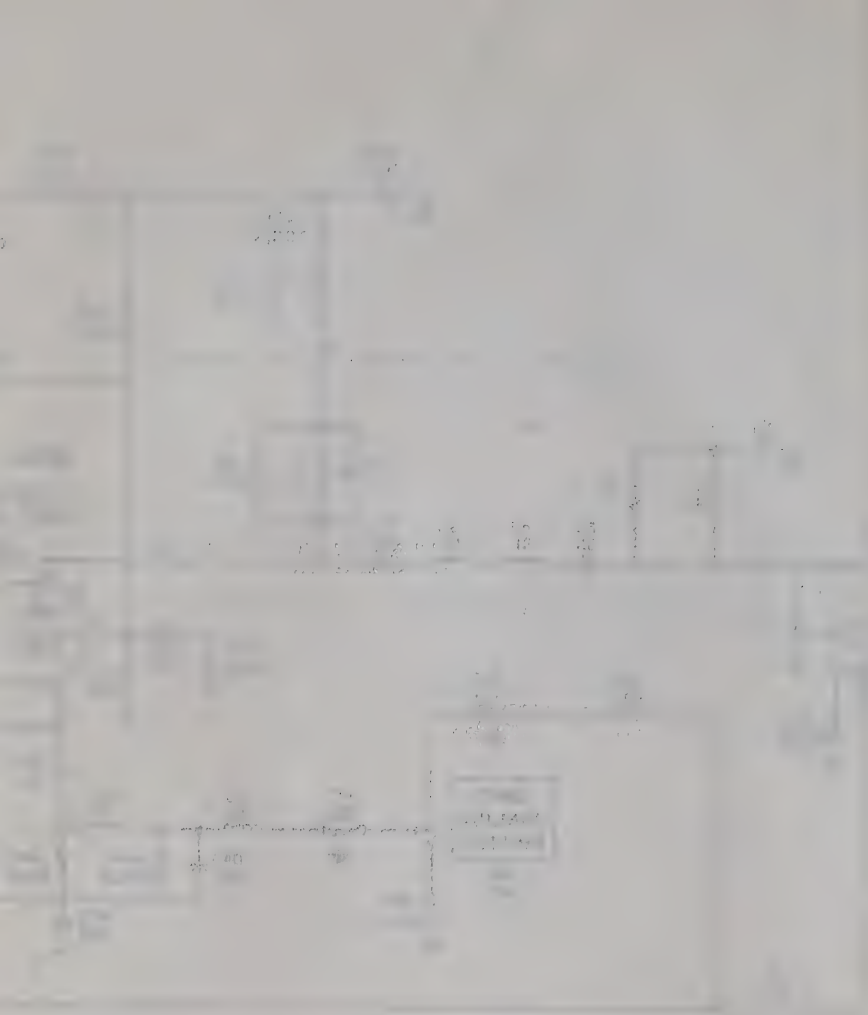


Figure 167. 8-mc IF amplifier No. 2 A4 (part of IF amplifier), complete schematic diagram.


NOTES:
1. UNLESS OTHERWISE
ALL RESISTANCE
ALL CAPACITANC
MICROMICROFARA
ALL INDUCTANCE
2. SYMBOL
IND
3. T2 TERMINAL IMPE
6-7 = 15KΩ
1-5 = 600Ω
4.
INDICATE
5. TERMINAL NUMBER
TOP
1
2
3
4
5
6
6. CONNECTOR VIEWE
SIDE
1 2 3 4
5 6 7 8
J8
CATHODE
FOLLOWER
V4B
(1/2) 5670
6
8
41
70K
C27
25UF
R42
180
R43
2,200
T2
7
6
1
2
3
4
5
PHONE
J7
J4
J18
ORDER WIRE
OUTPUT TO
MULTIPLEXER
J6
J26
REDUNDANCY
CONNECTION
PART OF
FL1
PART OF
J8
C1
1,000
L1
5.6
J11
4
-6.3 VDC
C7
1,000
L2
5.6
C3
1,000
L3
5.6
2
6.3 VAC
C8
1,000
V6
1
9
C6
1,000
L4
5.6
8
6.3 V AC
RETURN
C28
.01UF
1
GROUND
TM5820-469-30-10



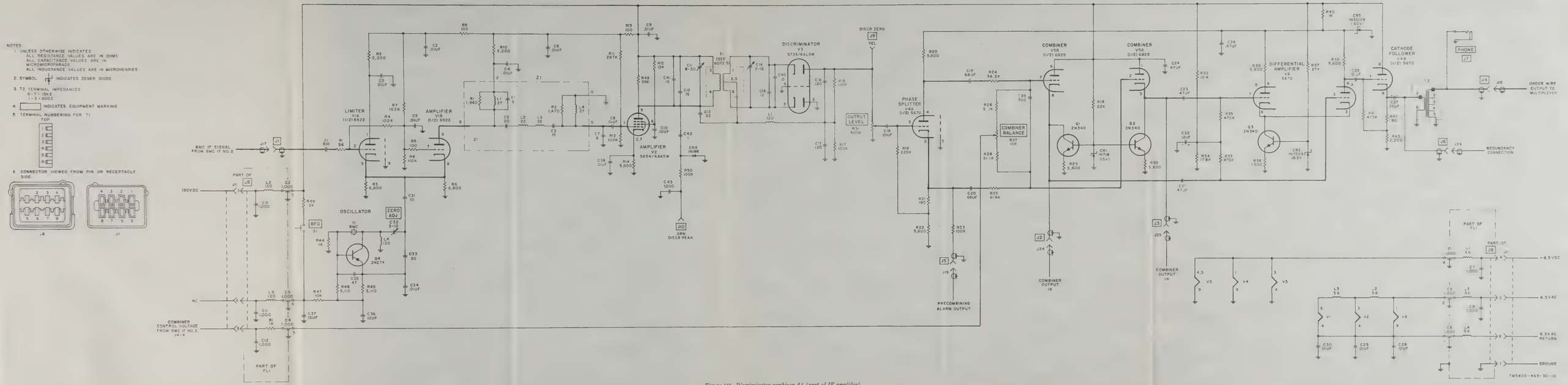
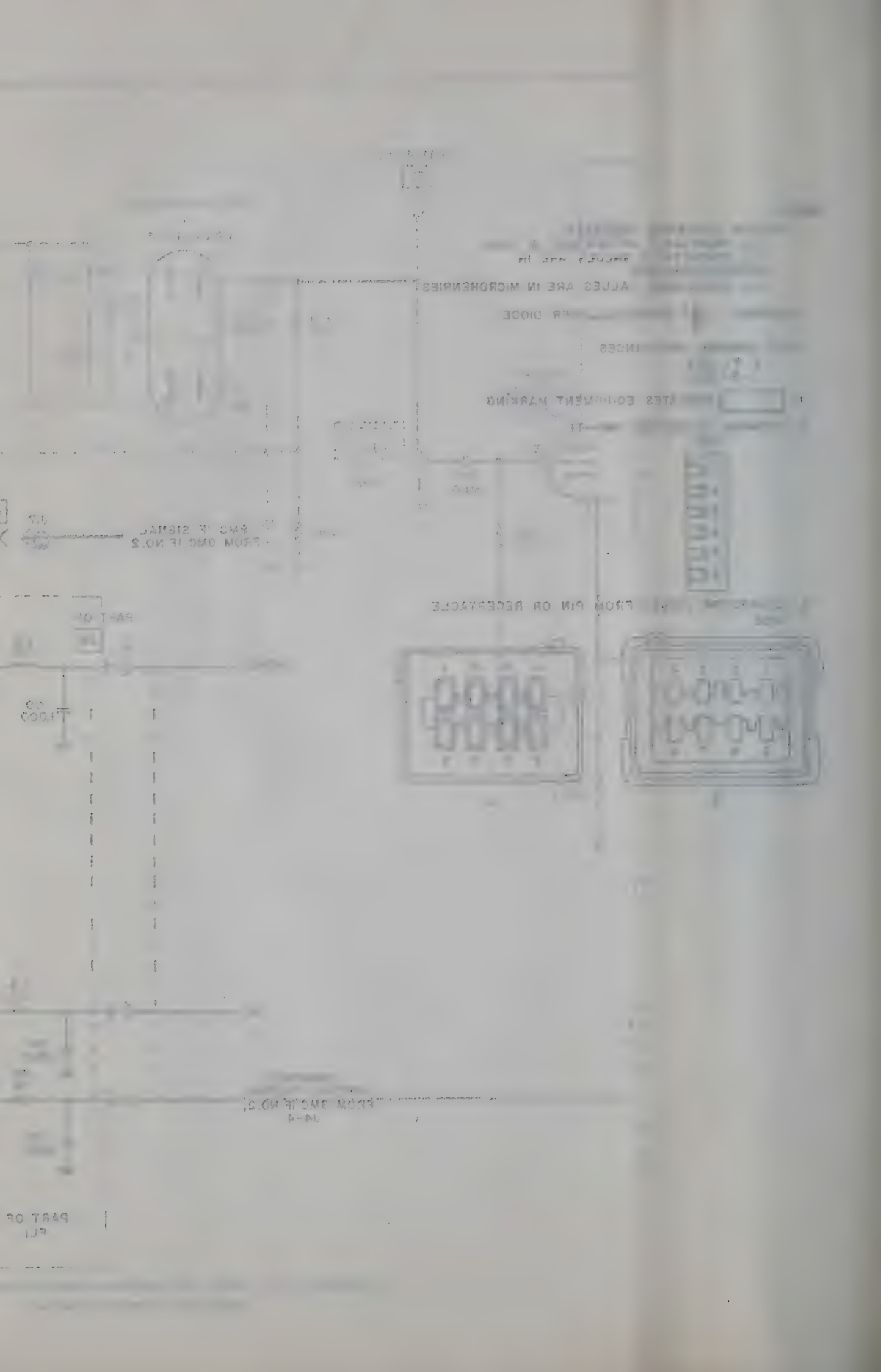
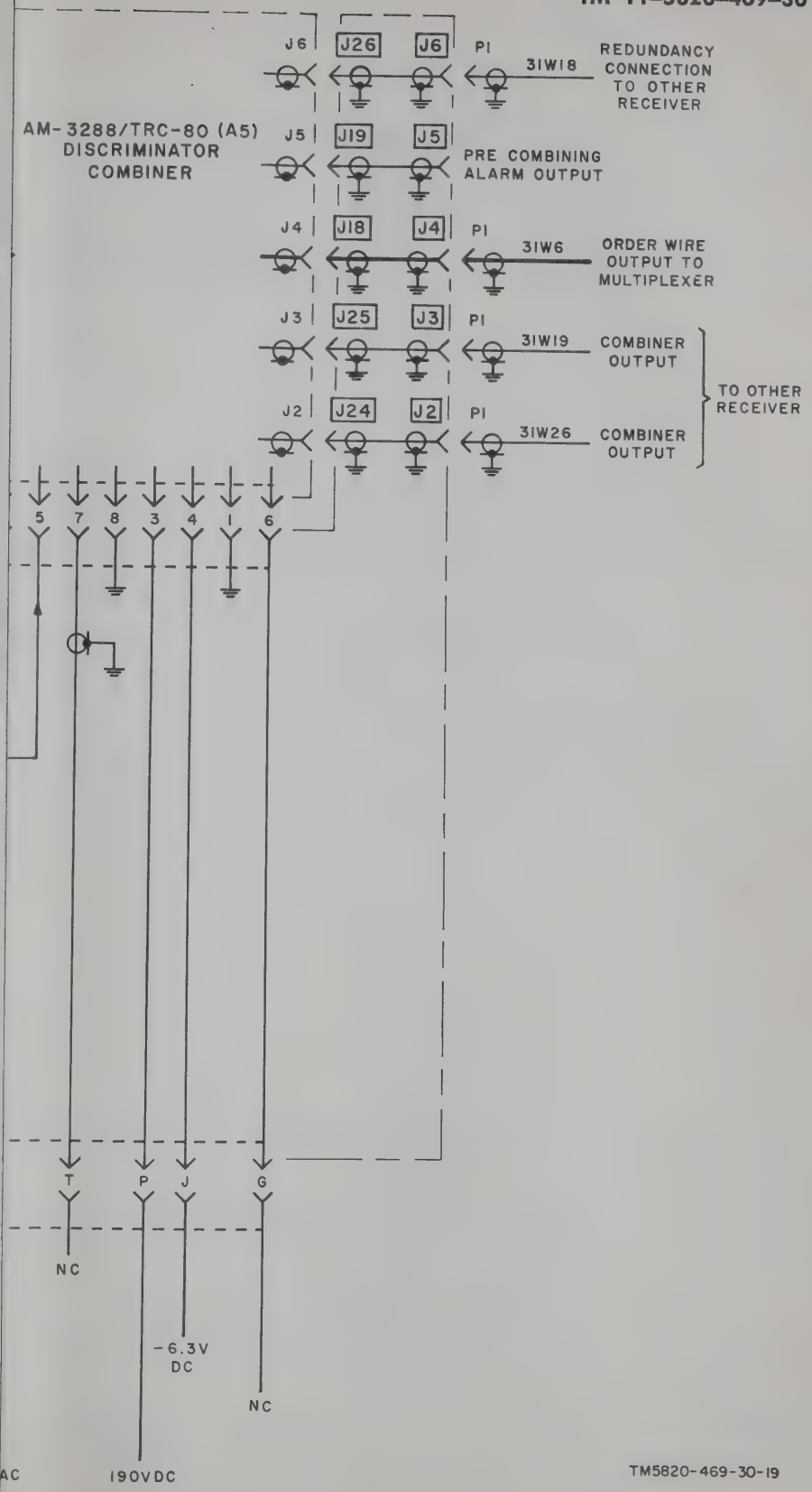
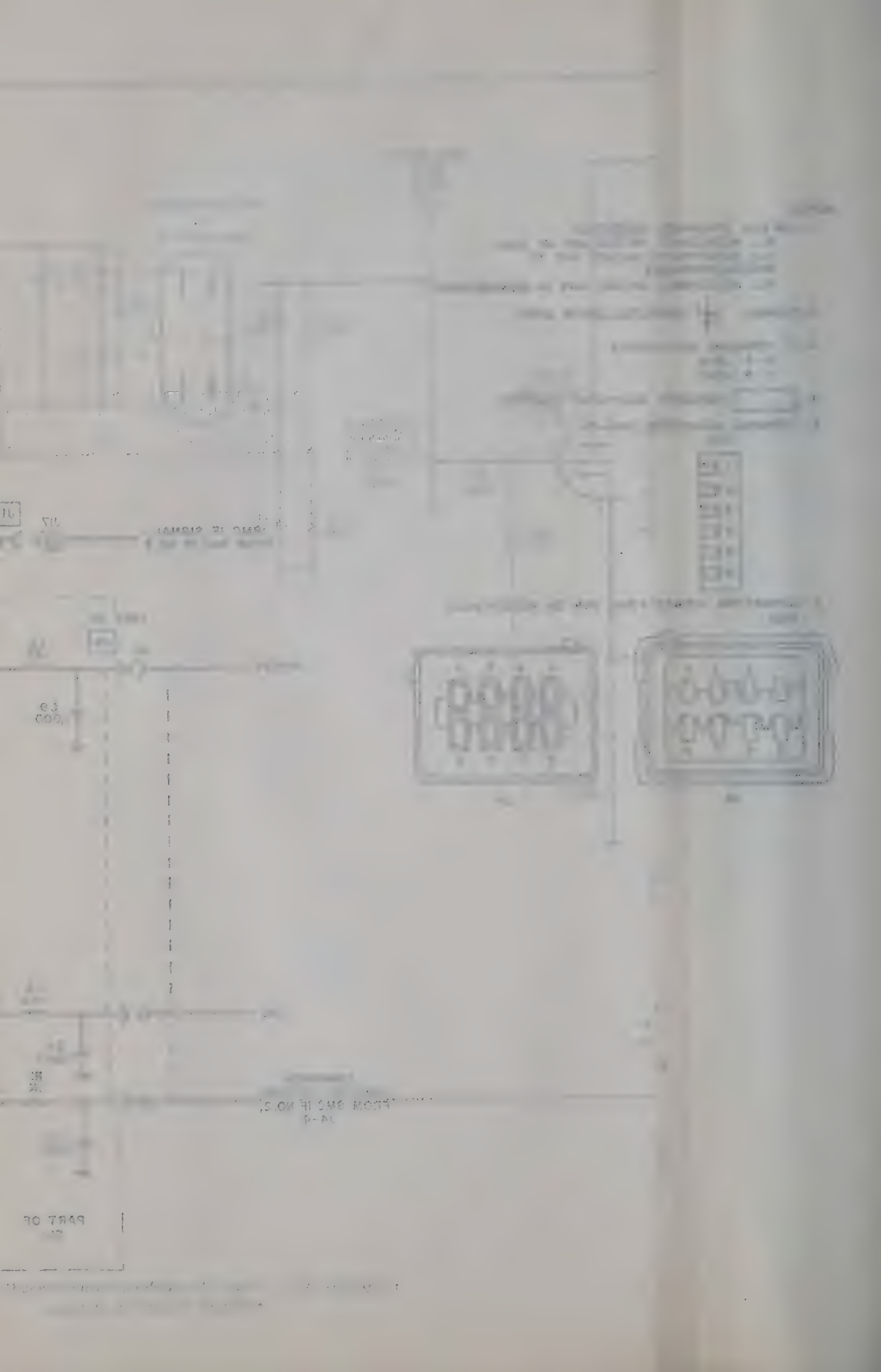


Figure 168. Discriminator combiner A5 (part of IF amplifier), complete schematic diagram.




AM-3288/TRC-80 (A5)
DISCRIMINATOR
COMBINER
J6
J26
J6
P1
31W18
REDUNDANCY
CONNECTION
TO OTHER
RECEIVER
J5
J19
J5
PRE COMBINING
ALARM OUTPUT
J4
J18
J4
P1
31W6
ORDER WIRE
OUTPUT TO
MULTIPLEXER
J3
J25
J3
P1
31W19
COMBINER
OUTPUT
J2
J24
J2
P1
31W26
COMBINER
OUTPUT
TO OTHER
RECEIVER
5
7
8
3
4
1
6
T
P
J
G
NC
-6.3V
DC
NC
AC
190VDC
TM5820-469-30-19



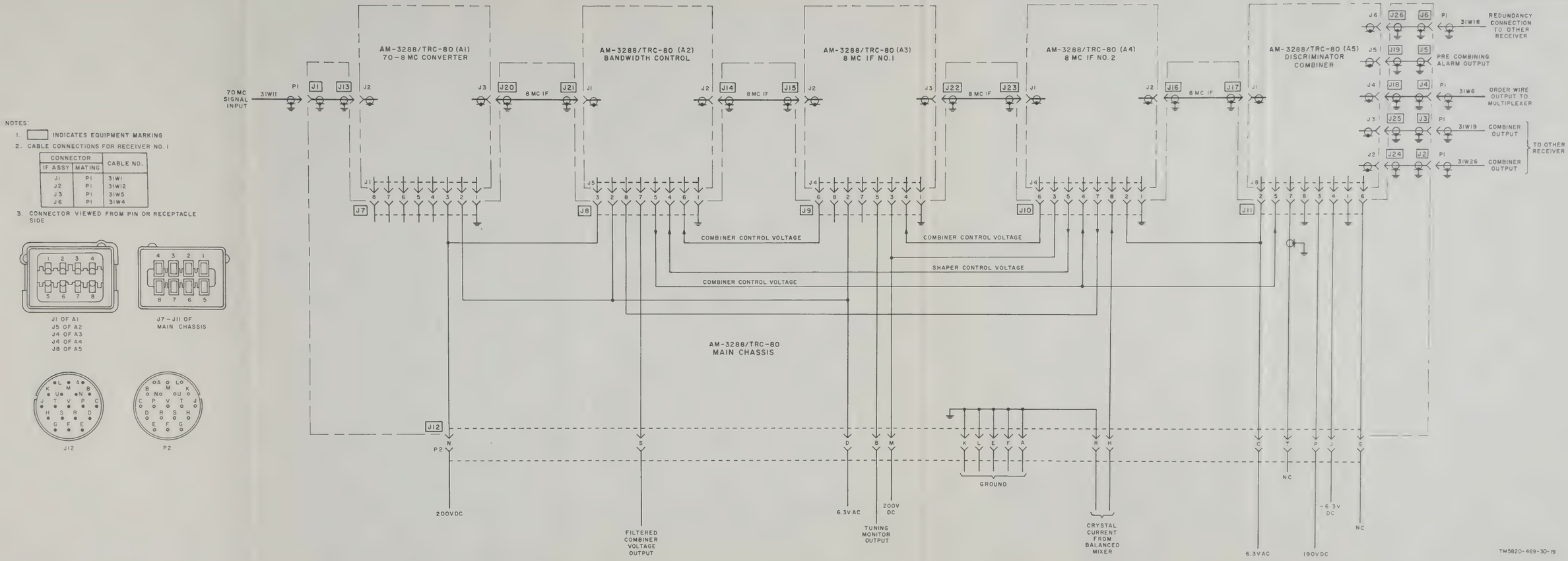
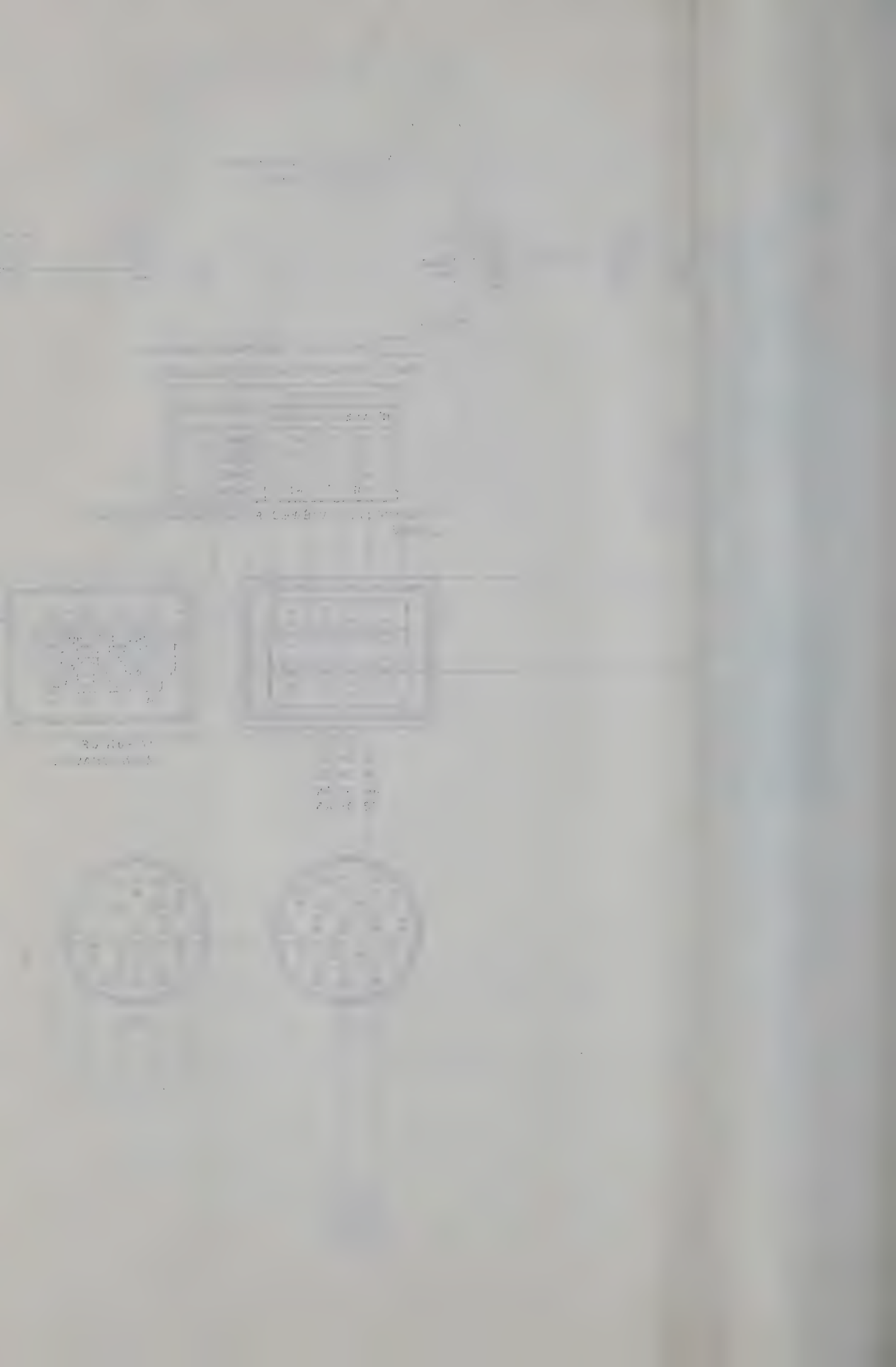


Figure 169. Intermediate Frequency Amplifier AM-3288/TRC-80, main frame, schematic diagram.



NOTES:

1. UNLESS
   ALL R
   ALL C
   ALL I

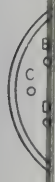
2. SYMBO

3. [ ]

4. WHEN R
   REMOVE
   AND TE
   120V AC
   OF J5.
   BETWEE

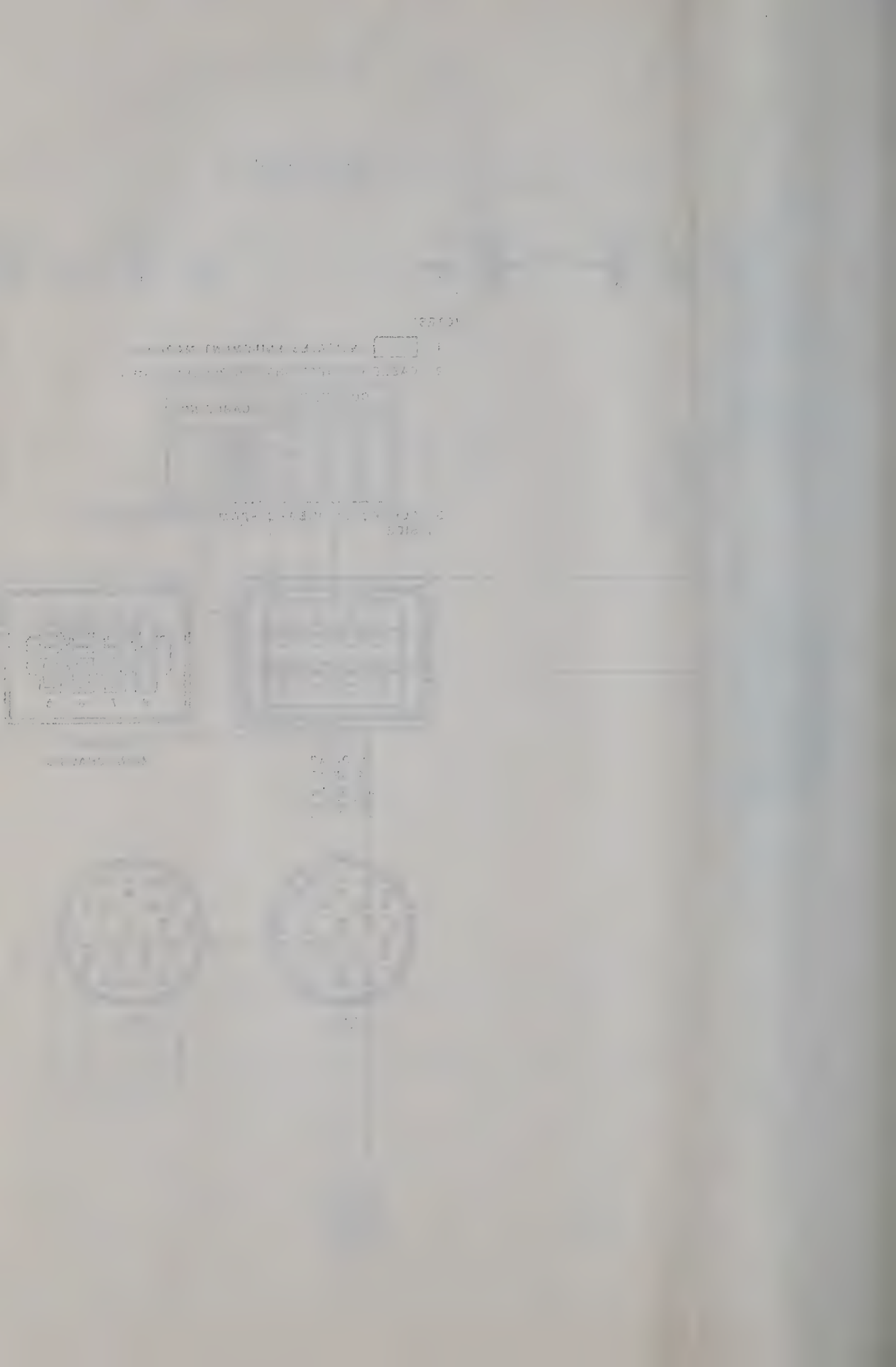
5. R111 IS
   TO PRO
   MAY NO

6. CONNEC



7. MATING

RACK
A4 A5

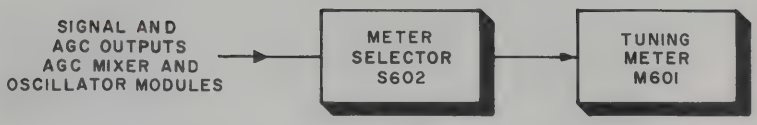


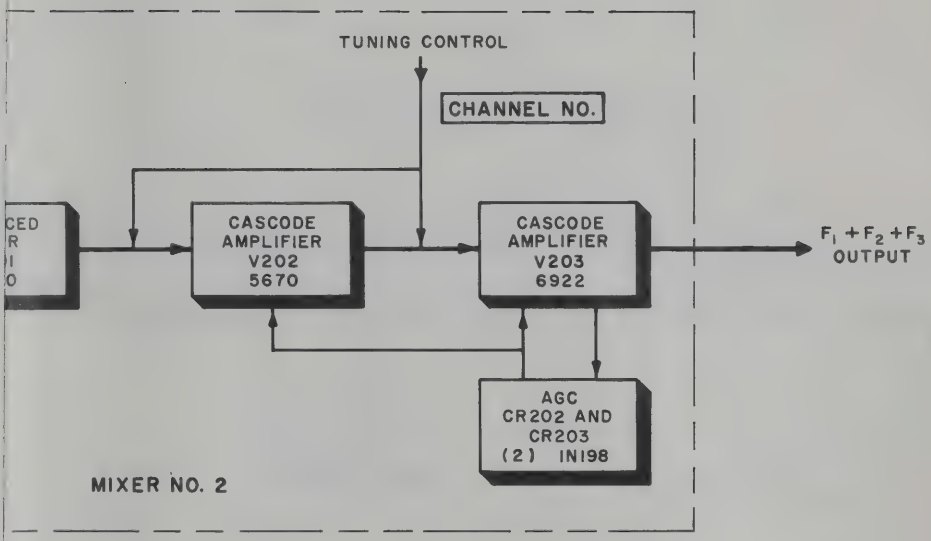
NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MILLIHENRIES
2. SYMBOL INDICATES A ZENER DIODE
3. INDICATES EQUIPMENT MARKING
4. WHEN REGULATED 6.3V AC FILAMENTS ARE REQUIRED, REMOVE THE JUMPERS FROM TERMINALS 1 AND 2, AND TERMINALS 3 AND 4 OF TB1. CONNECT THE 120V AC REGULATED SOURCE BETWEEN PINS A AND G OF J5. CONNECT THE UNREGULATED 120V AC SOURCE BETWEEN PINS B AND H OF J5.
5. R111 IS INSTALLED DURING MANUFACTURE AS REQUIRED TO PRODUCE AN OUTPUT OF 200V DC. THE VALUE MAY NOT BE 470K
6. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE

7. MATING CONNECTORS FOR J5 BY RACK LOCATION

RACK	MATING CONNECTORS	CABLE NO
A4	P3	31W72
A5	P3	

Figure 170. Power Supply PP-3313/TRC-80 (IF amplifier power supply) complete schematic diagram.





CHANNEL					
HUNDREDS		TENS		UNITS	
DIAL	F_3 (MC)	DIAL	F_2 (MC)	DIAL	F_1 (MC)
0	20.00	0	2.3125	0	0.3250
1	21.25	1	2.4375	1	0.3375
2	22.50	2	2.5625	2	0.3500
3	23.75	3	2.6875	3	0.3625
4	25.00	4	2.8125	4	0.3750
5	26.25	5	2.9375	5	0.3875
6	27.50	6	3.0625	6	0.4000
7	28.75	7	3.1975	7	0.4125
8	30.00	8	3.3125	8	0.4250
9	31.25	9	3.4375	9	0.4375

NOTE:

MARKING — INDICATES EQUIPMENT

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NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. [ ] INDICATES EQUIPMENT MARKING
3. SYMBOL [A] INDICATES ZENER DIODE
4. CUSTOM MODIFICATION:
   WHEN REGULATED 6.3 VOLT FILAMENTS ARE REQUIRED, REMOVE THE JUMPERS FROM TERMINALS 1 AND 2, AND TERMINALS 3 AND 4 OF TB1. CONNECT 120V AC REGULATED SOURCE TO PIN P OF J4. CONNECT THE REGULATED NEUTRAL TO PIN T OF J4. CONNECT 120V AC UNREGULATED SOURCE TO PIN R OF J4. CONNECT THE UNREGULATED NEUTRAL TO PIN U OF J4.
5. R111 IS FACTORY INSTALLED TO PRODUCE AN OUTPUT OF 200VDC. THE VALUE MAY NOT BE 470K
6. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE.

7. MATING CONNECTORS FOR J4 BY RACK LOCATION

LOCATION	MATING CONNECTORS
A5-A4	P4
A5-A5	P5

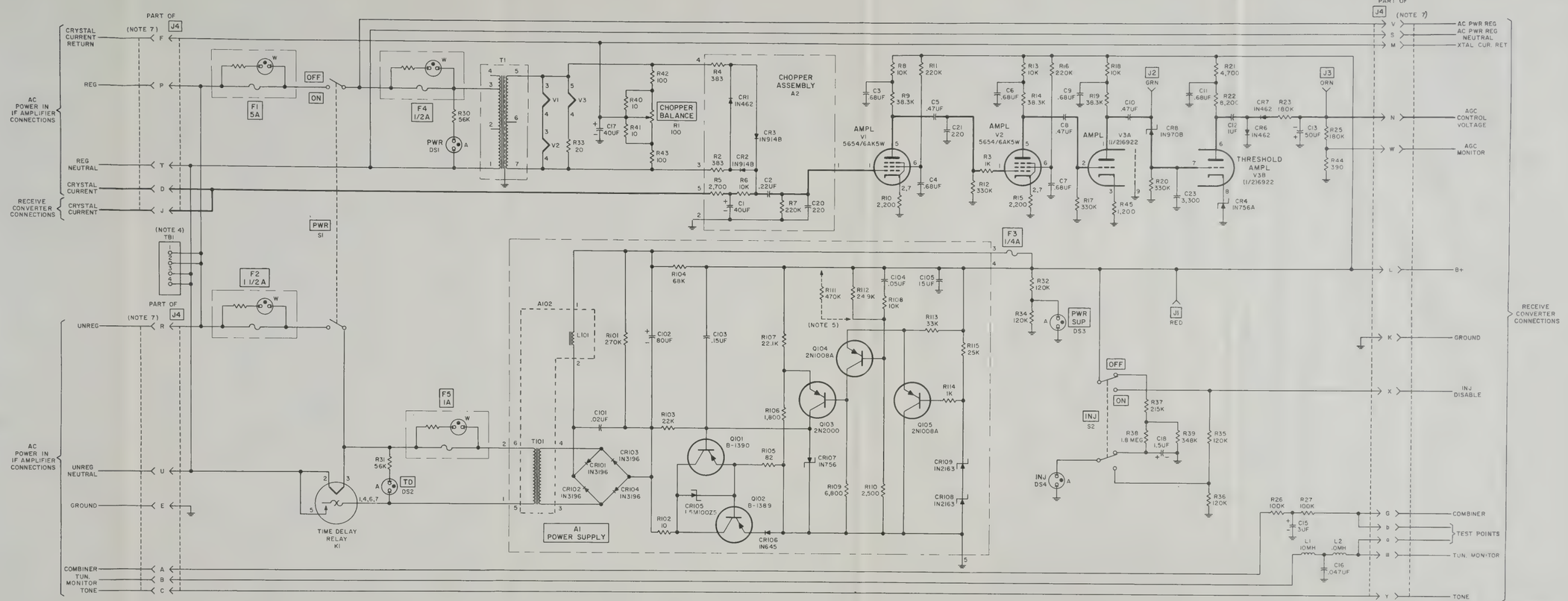

Figure 171. Power Supply PP-3314/TRC-80 (receive converter power supply), complete schematic diagram.

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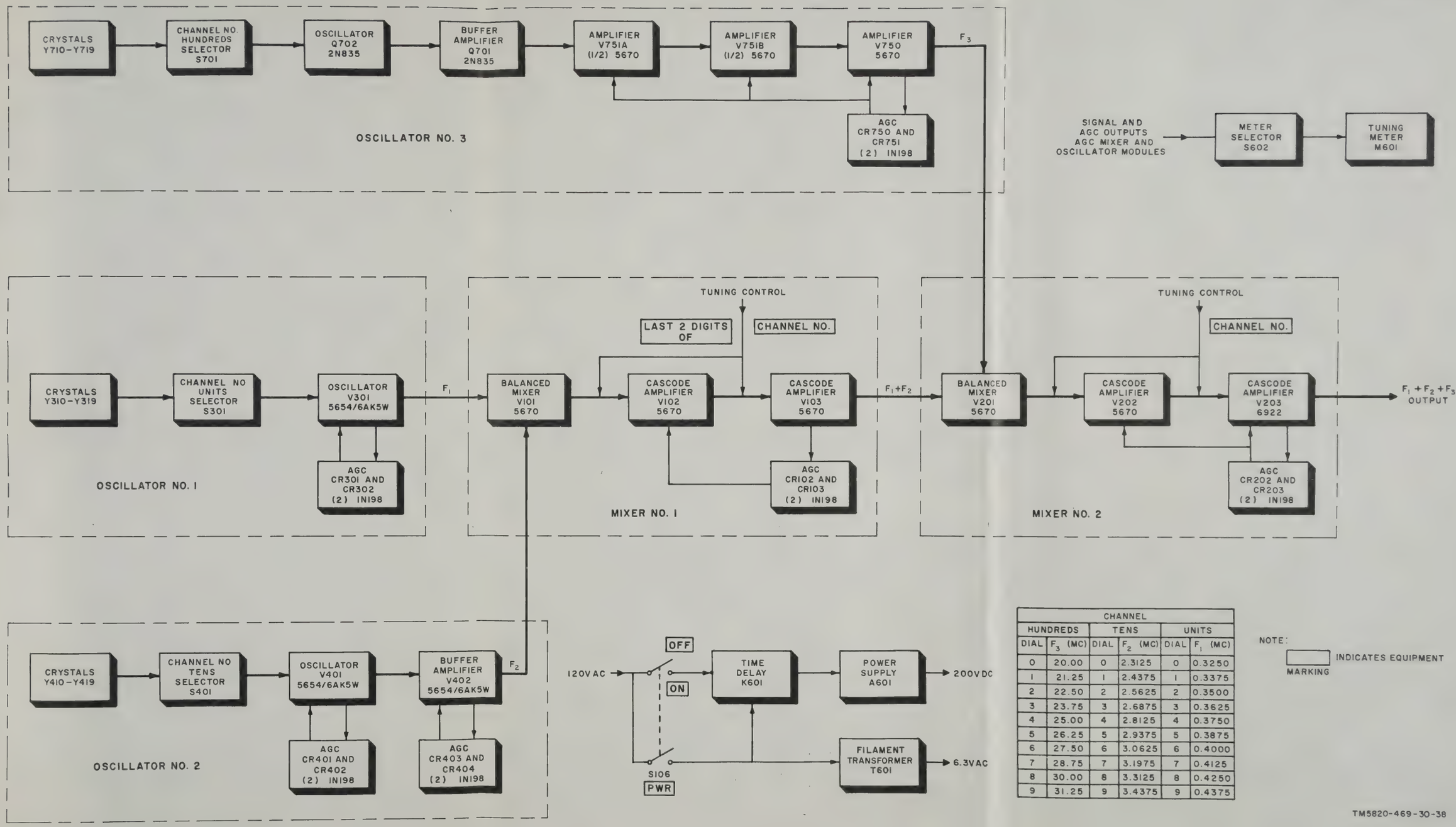
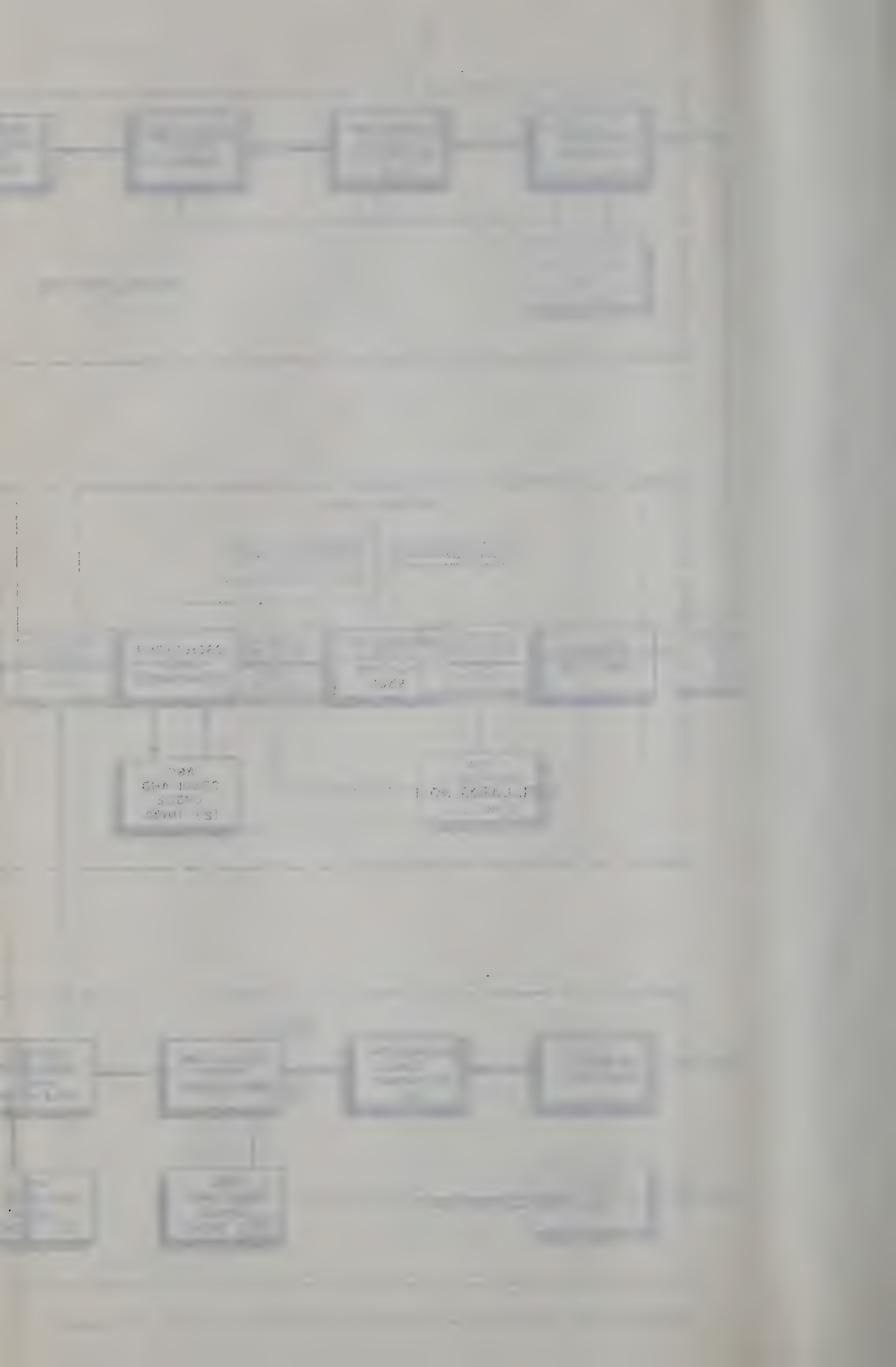


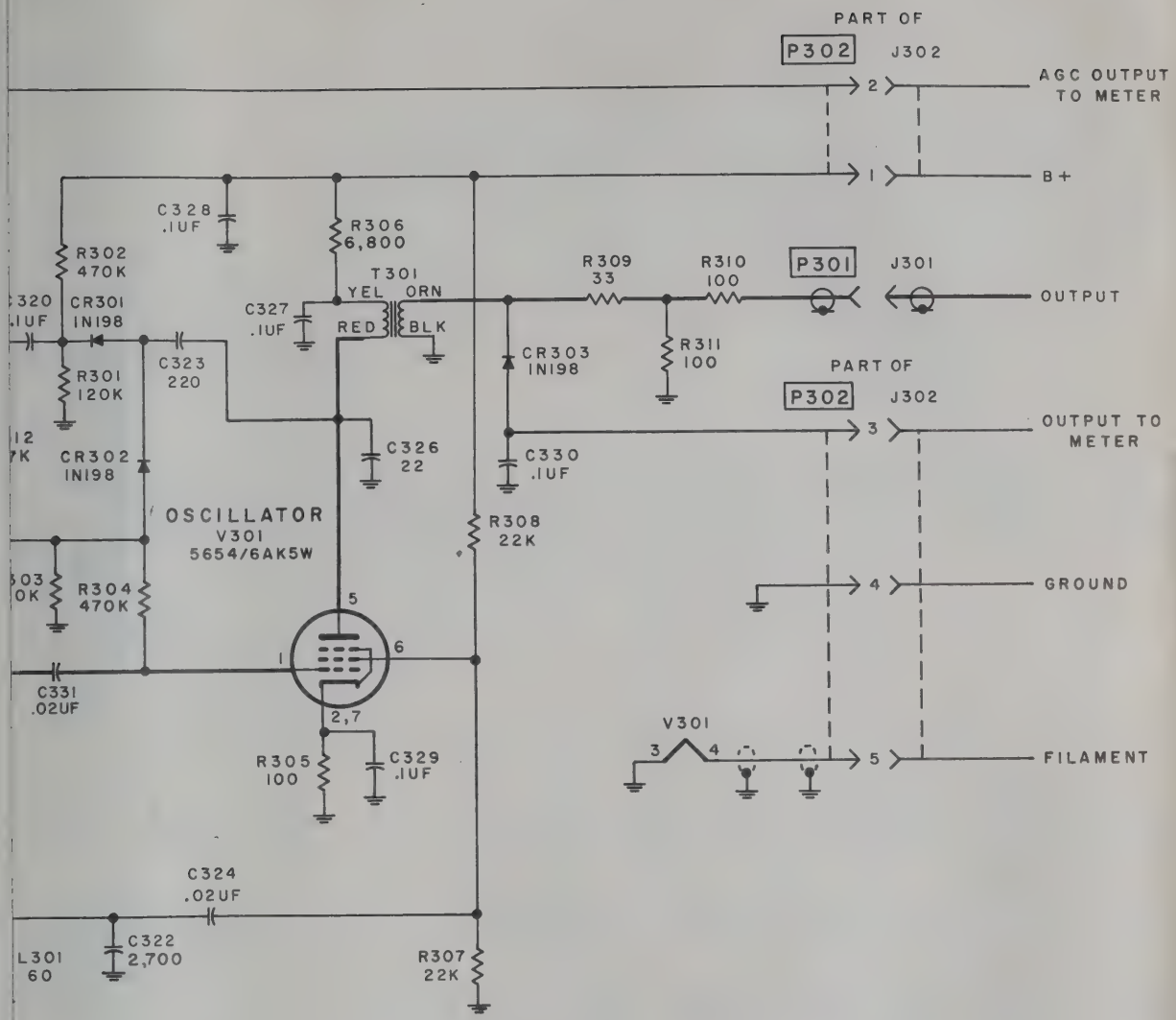
CHANNEL					
HUNDREDS		TENS		UNITS	
DIAL	F_3 (MC)	DIAL	F_2 (MC)	DIAL	F_1 (MC)
0	20.00	0	2.3125	0	0.3250
1	21.25	1	2.4375	1	0.3375
2	22.50	2	2.5625	2	0.3500
3	23.75	3	2.6875	3	0.3625
4	25.00	4	2.8125	4	0.3750
5	26.25	5	2.9375	5	0.3875
6	27.50	6	3.0625	6	0.4000
7	28.75	7	3.1975	7	0.4125
8	30.00	8	3.3125	8	0.4250
9	31.25	9	3.4375	9	0.4375

NOTE:
MARKING — INDICATES EQUIPMENT

TM5820-469-30-38

Figure 172. Electrical Frequency Synthesizer 0-937/TRC-80, block diagram.



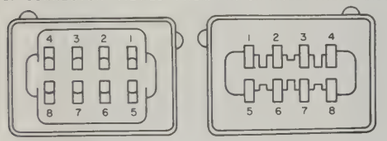


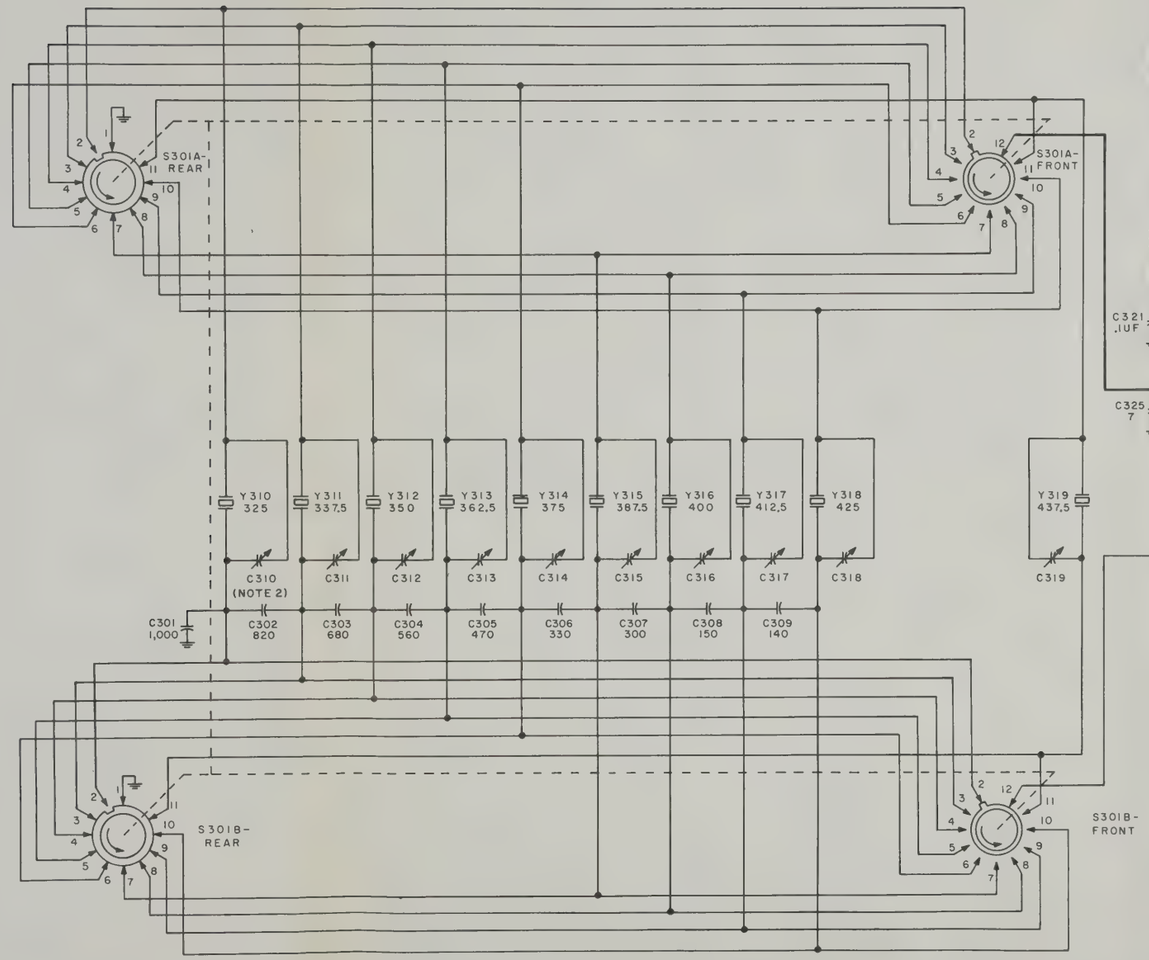
TM5820-469-30-15

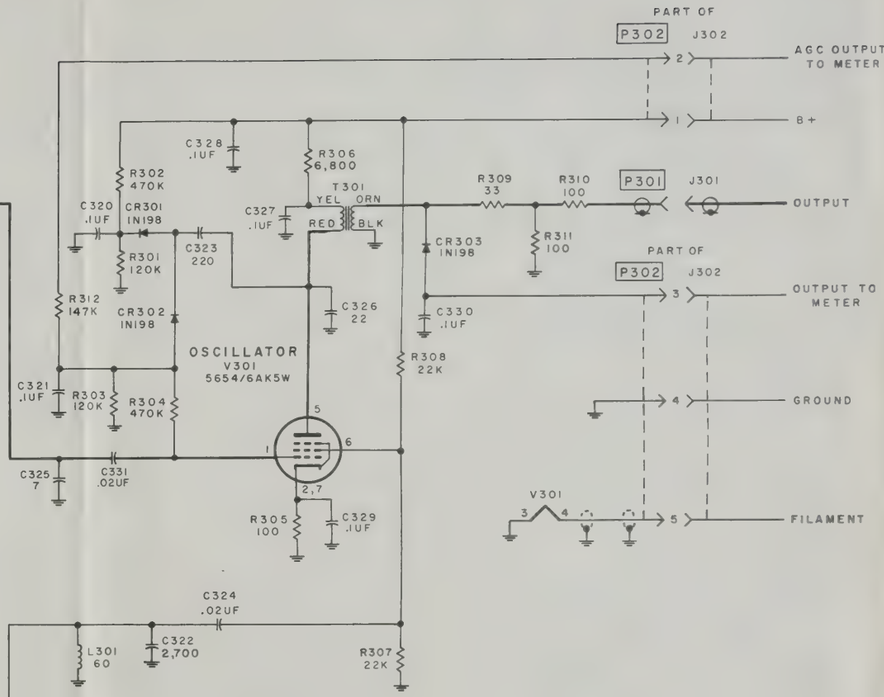
NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
   ALL CRYSTAL FREQUENCIES ARE IN KILOCYCLES
2. ALL VARIABLE CAPACITORS ARE 5-25 UUF
3. ALL WAFER SWITCHES ARE VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
4. SWITCH POSITIONS OF S301

5. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE

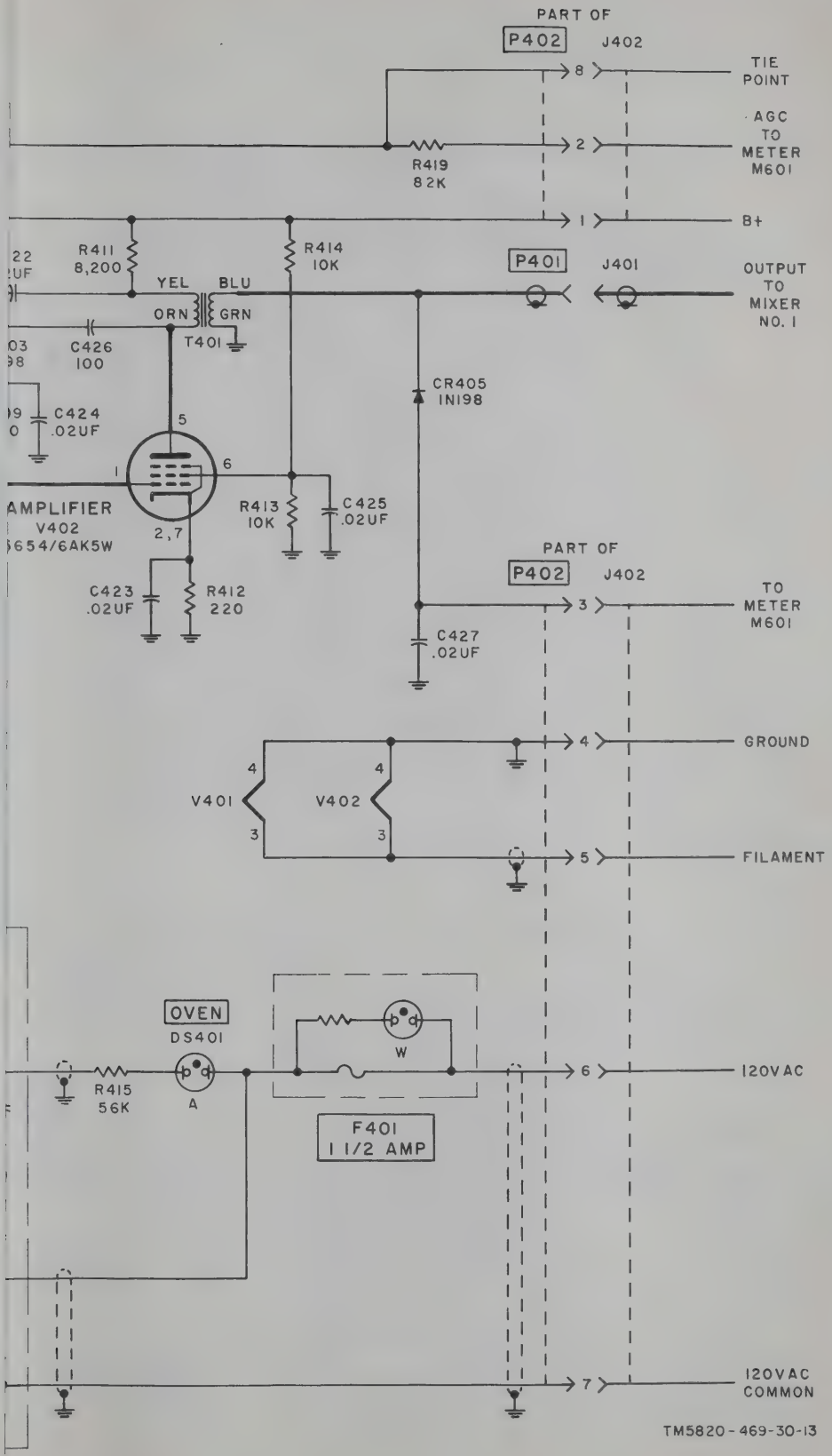






TM5820-469-30-15

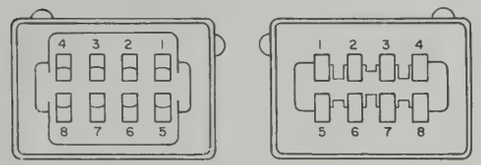
Figure 173. Oscillator No. 1 (part of synthesizer), complete schematic diagram.


PART OF
P402
J402
8
TIE POINT
2
AGC TO METER M601
R419 82K
1
B+
R411 8,200
R414 10K
P401
J401
OUTPUT TO MIXER NO. 1
YEL
BLU
ORN
GRN
T401
C426 100
CR405 IN198
C424 .02UF
5
1
6
AMPLIFIER V402 6654/6AK5W
2,7
R413 10K
C425 .02UF
C423 .02UF
R412 220
PART OF
P402
J402
3
TO METER M601
C427 .02UF
4
GROUND
V401
V402
4
3
4
3
5
FILAMENT
OVEN
DS401
W
R415 56K
A
6
120VAC
F401 1 1/2 AMP
7
120VAC COMMON
TM5820-469-30-13

NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
   ALL CRYSTAL FREQUENCIES ARE IN MEGACYCLES
2. [ ] INDICATES EQUIPMENT MARKING
3. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE THE KNOB OR DRIVEN END
4. SWITCH POSITIONS OF S401

5. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



6. CAPACITORS C401, C402, C403, C404, C405, C420, C421, C422, C423 C424, AND C425 ARE 4,700 UUF ON SOME UNITS

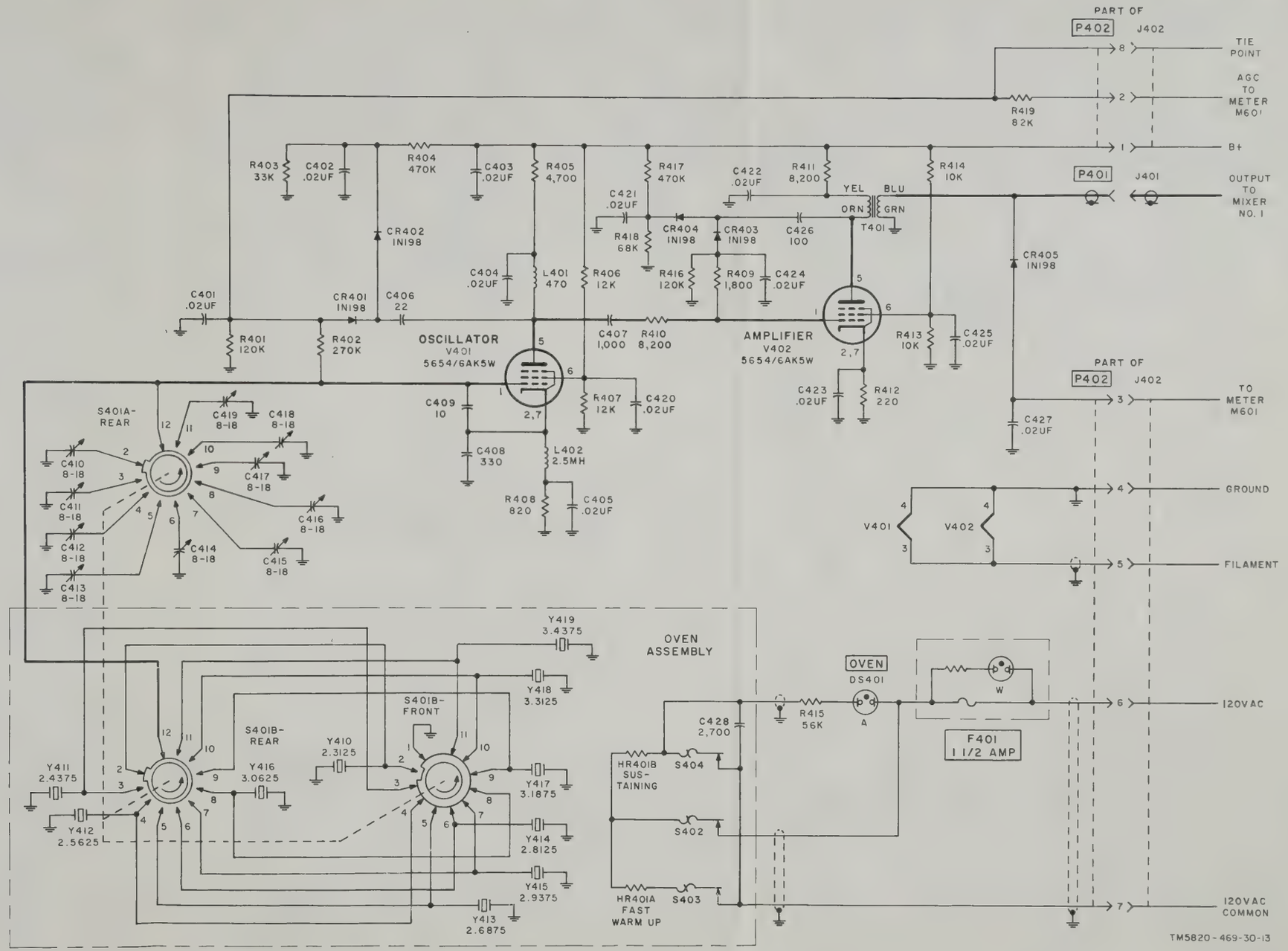
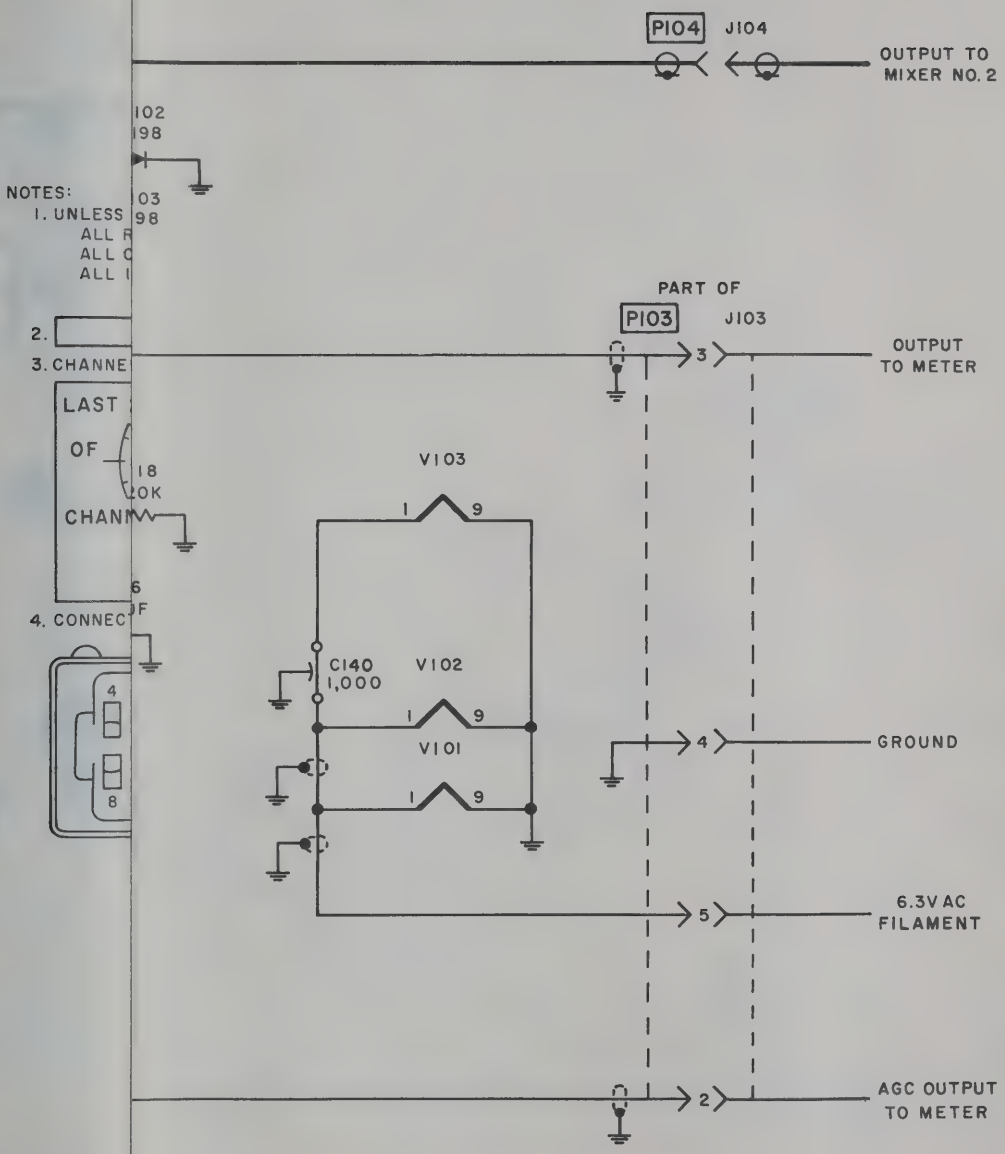
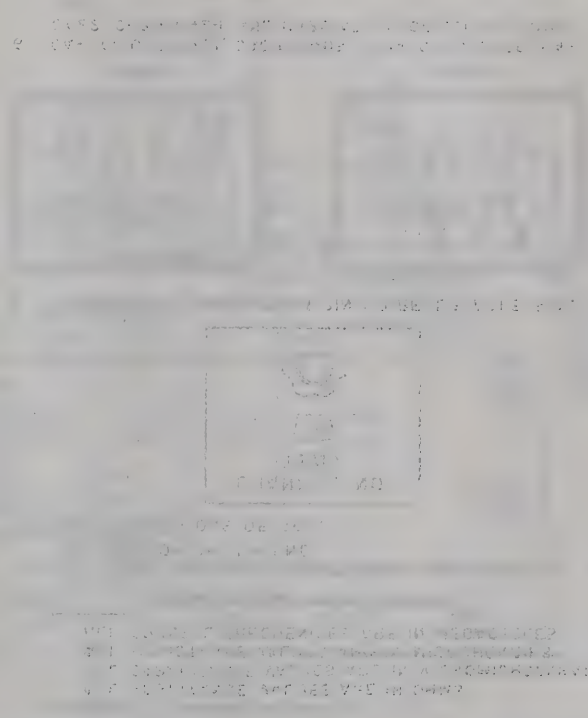


Figure 174. Oscillator No. 2 (part of synthesizer), complete schematic diagram.



TM5820-469-30-16



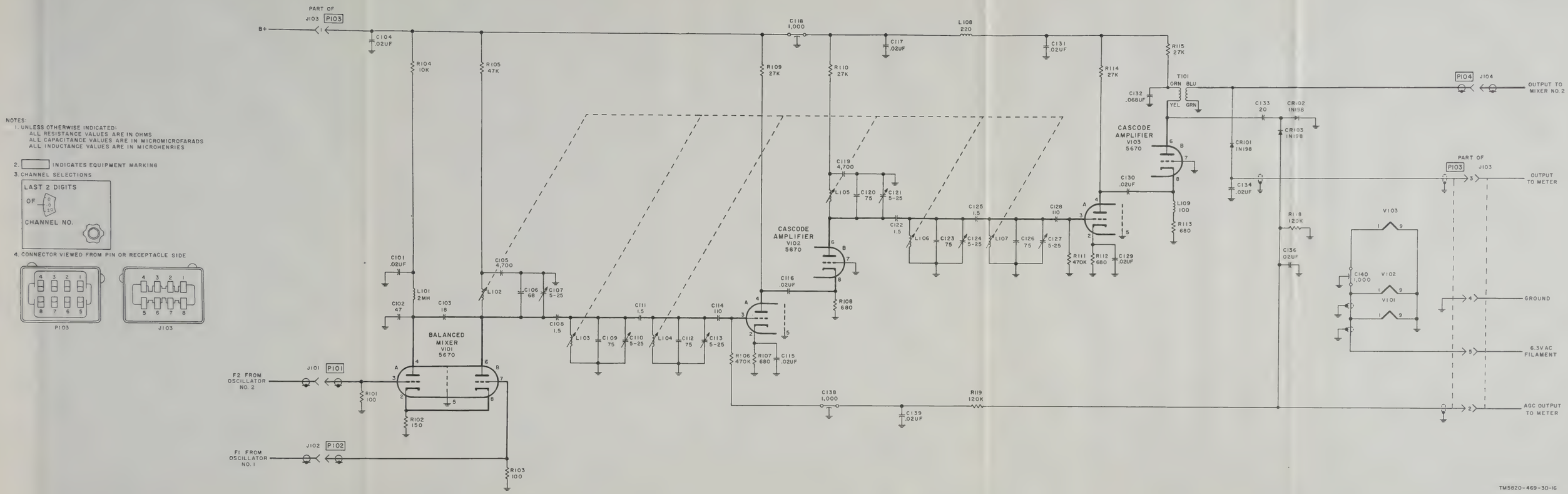
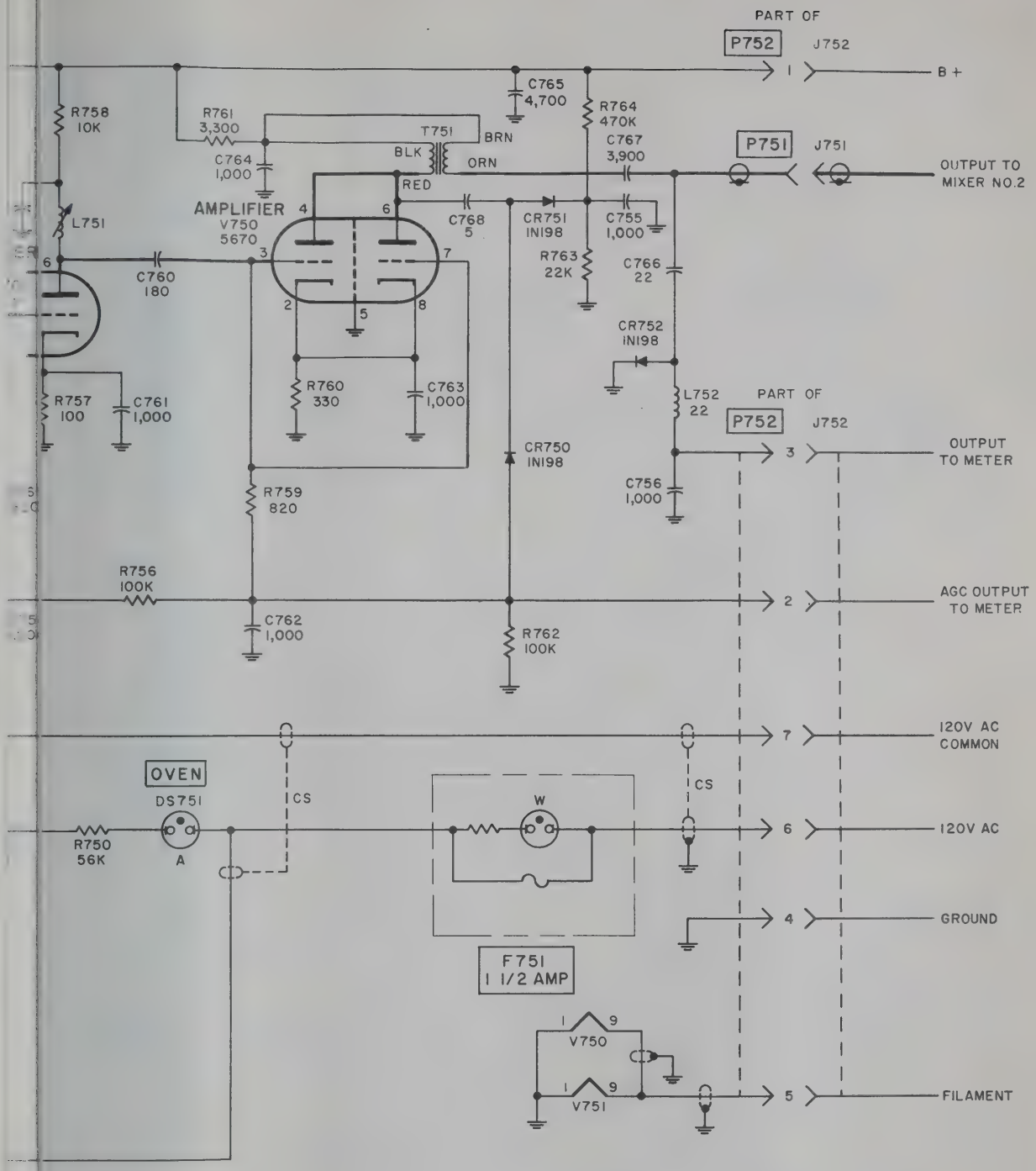


Figure 175. Mixer No. 1 (part of synthesizer), complete schematic diagram.



TM5820-469-30-18

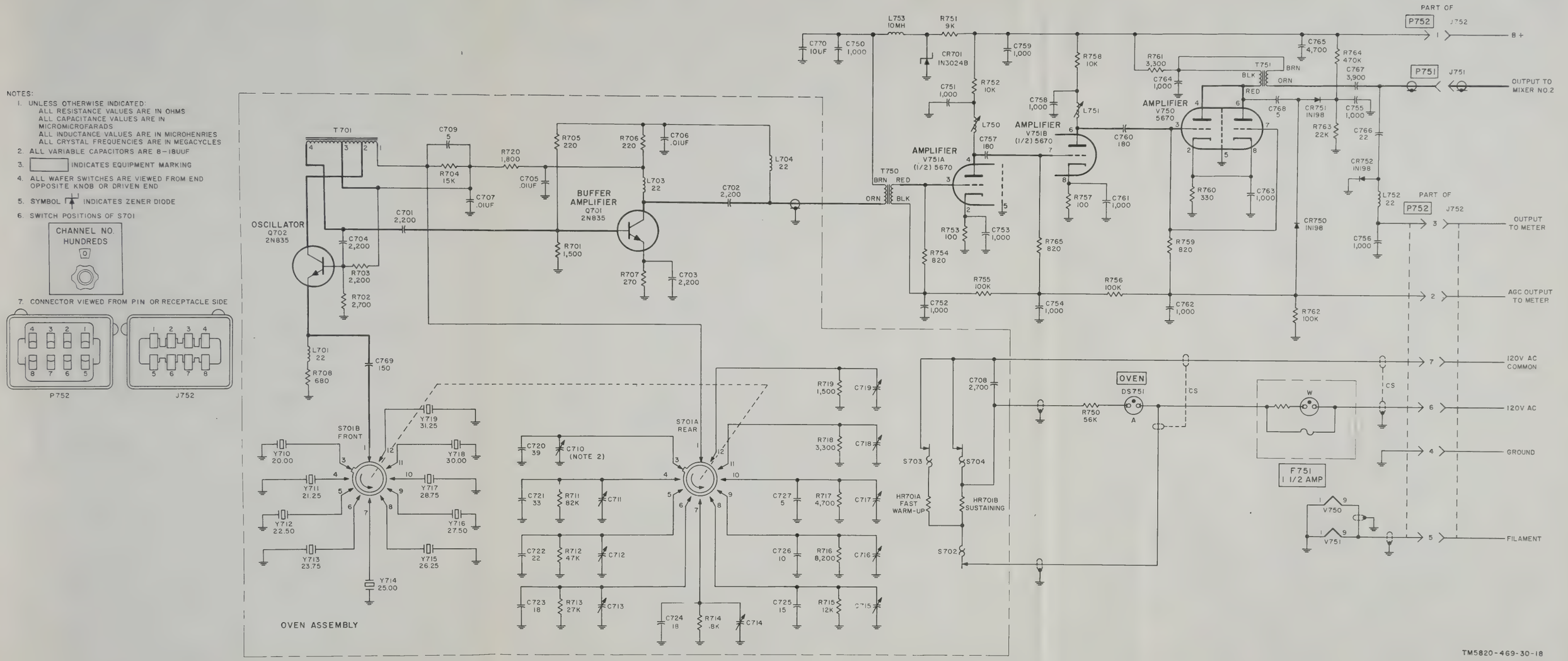
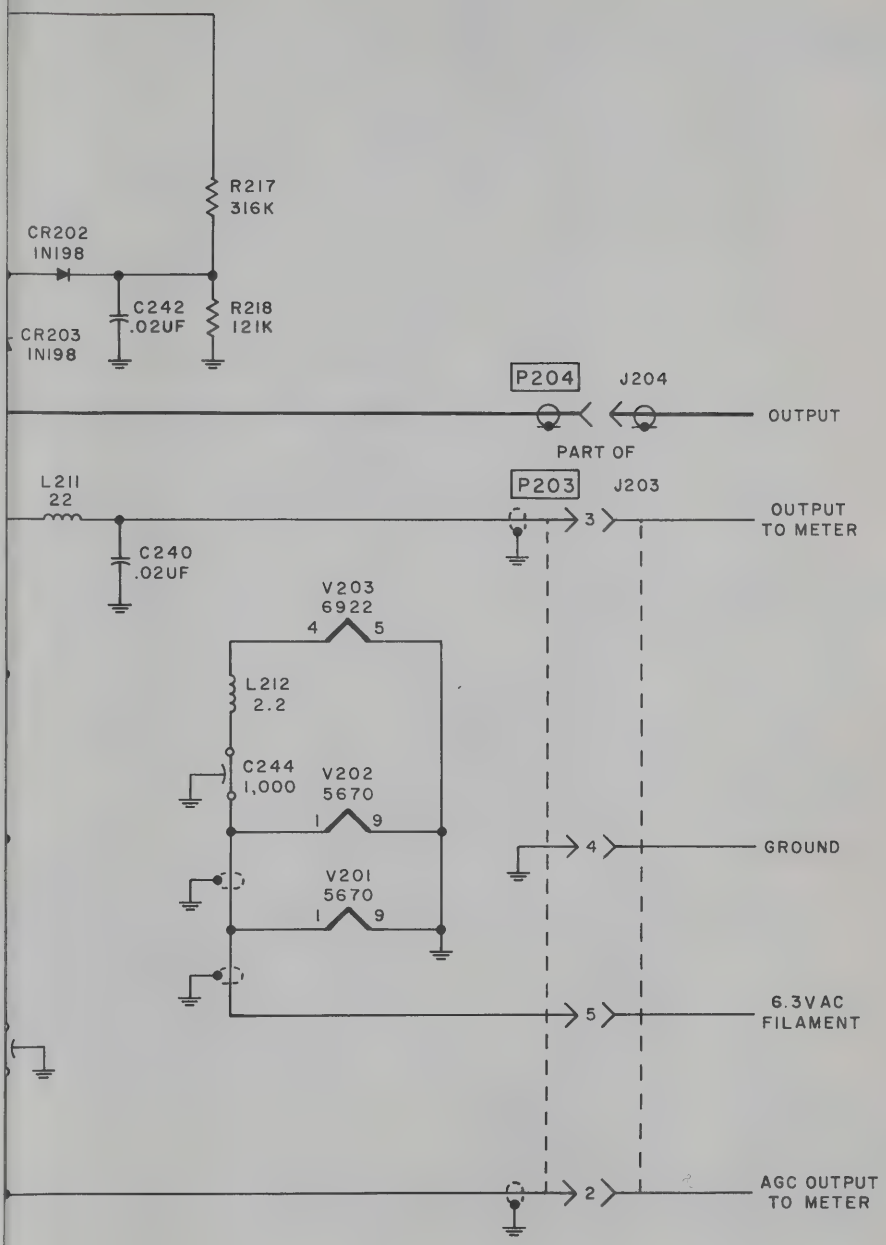
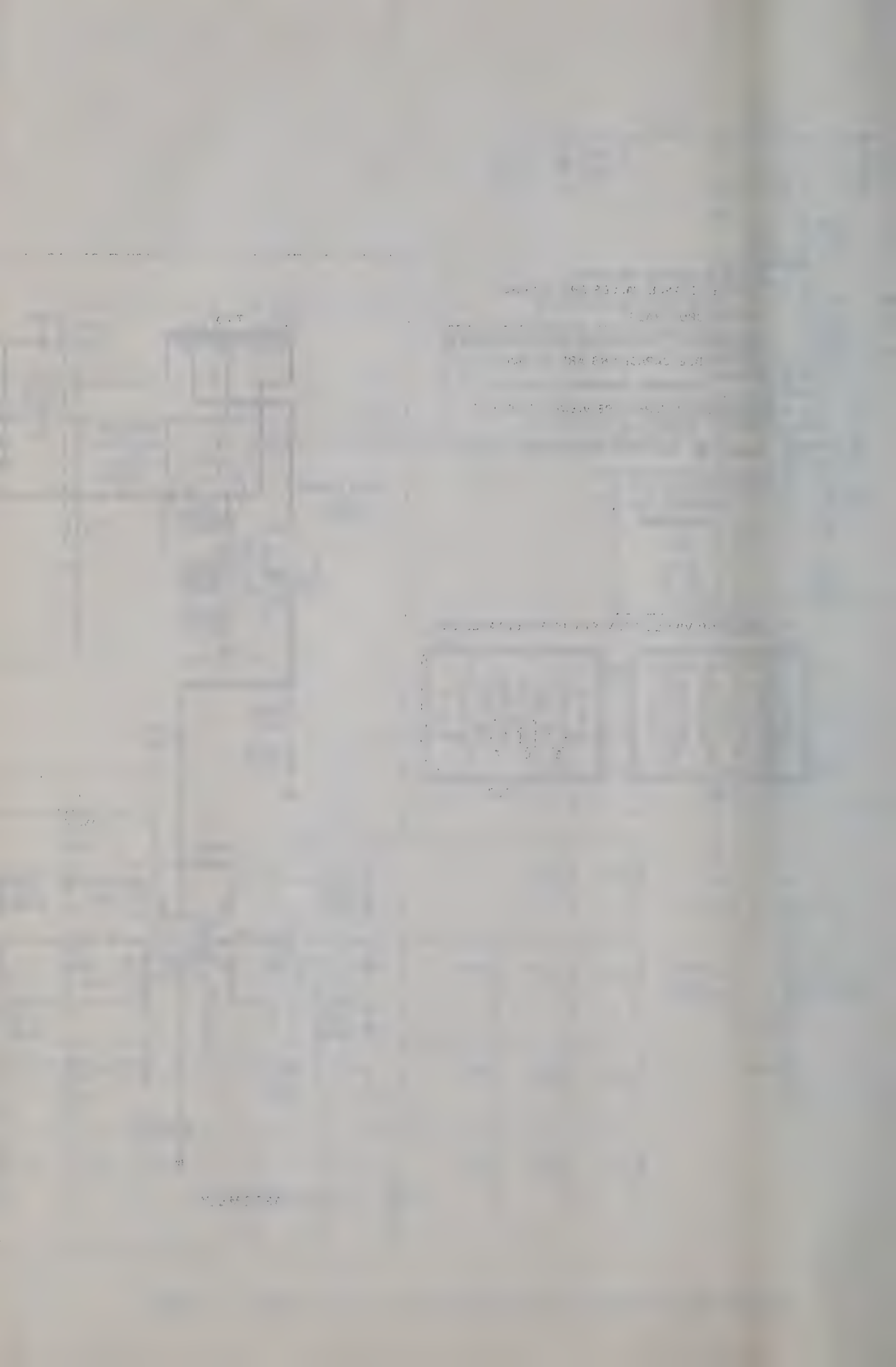


Figure 176. Oscillator No. 8 (part of synthesizer), complete schematic diagram.



TM5820-469-30-17



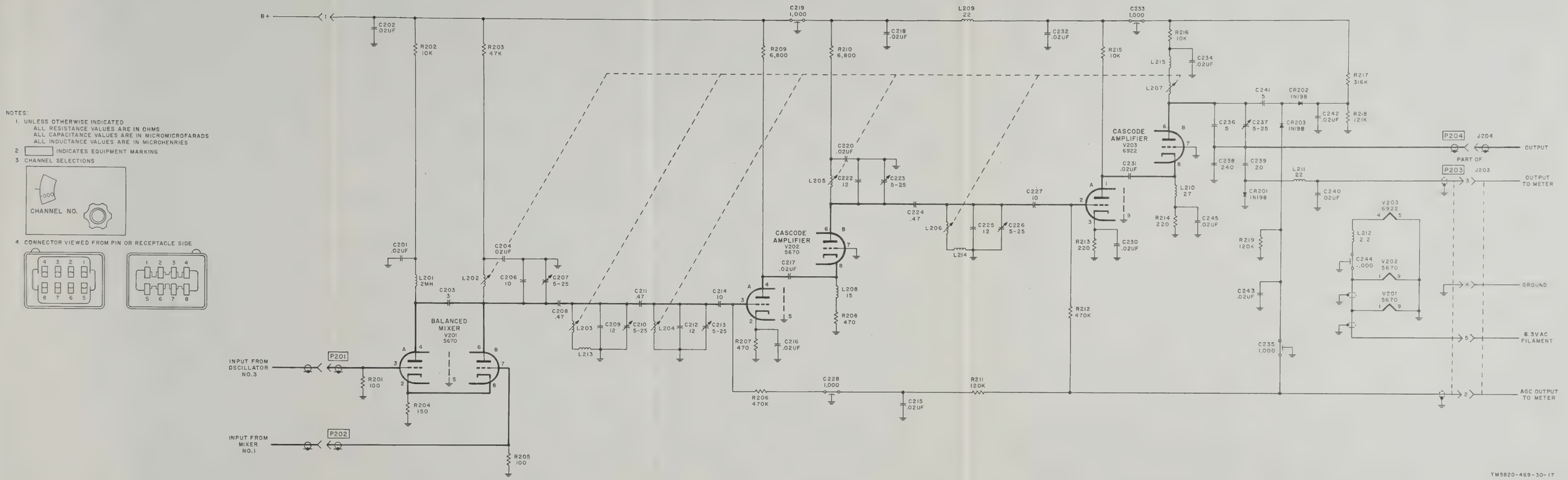
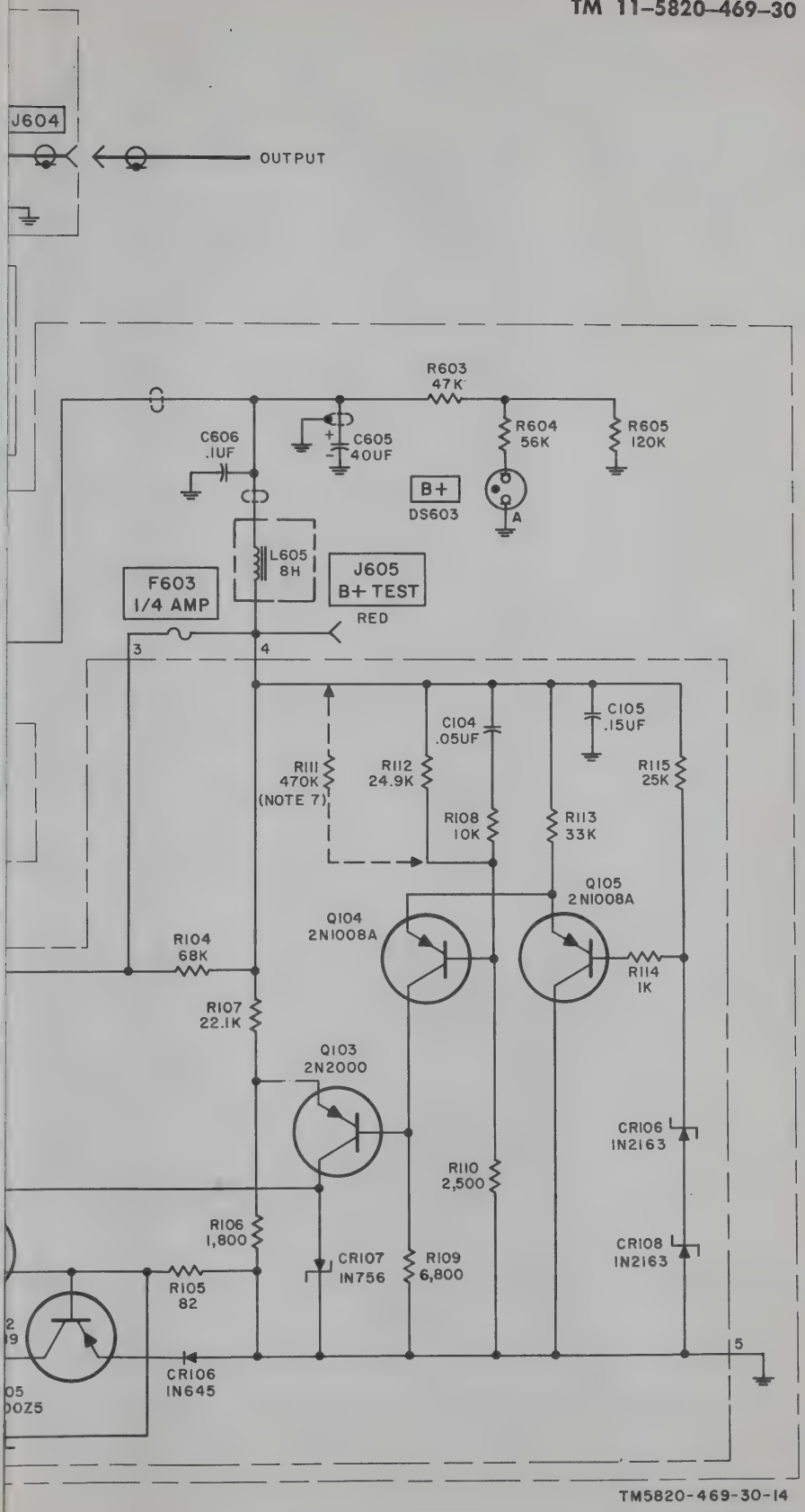
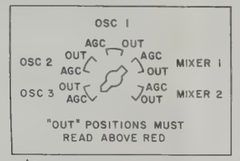


Figure 177. Mixer No. 2 (part of synthesizer), complete schematic diagram.

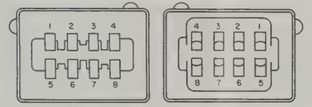

J604
OUTPUT
R603
47K
C606
.1UF
C605
40UF
R604
56K
R605
120K
B+
DS603
A
L605
8H
F603
1/4 AMP
J605
B+ TEST
RED
3
4
C104
.05UF
C105
.15UF
R111
470K
(NOTE 7)
R112
24.9K
R115
25K
R108
10K
R113
33K
Q105
2N1008A
Q104
2N1008A
R104
68K
R114
1K
R107
22.1K
Q103
2N2000
CR106
IN2163
R110
2,500
R106
1,800
CR107
IN756
R109
6,800
CR108
IN2163
R105
82
5
CR106
IN645
TM5820-469-30-14

NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. [ ] INDICATES EQUIPMENT MARKING
3. ALL WAFER SWITCHES ARE VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
4. SWITCH POSITIONS OF S602



5. SYMBOL ⊣⊢ INDICATES ZENER DIODE
6. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



J103, J201, J302, J402 AND J752 — P203, P201, P302, P402 AND P752

7. R111 IS FACTORY INSTALLED TO PRODUCE AN OUTPUT OF 200V DC. THE VALUE MAY NOT BE 470K
8. JUMPERS BETWEEN TERMINALS 4 AND 2 AND 3 AND 1 MAY BE REMOVED IF IT IS DESIRED TO OPERATE FILAMENT CIRCUIT AND DC POWER SUPPLY FROM SEPERATE POWER SOURCES

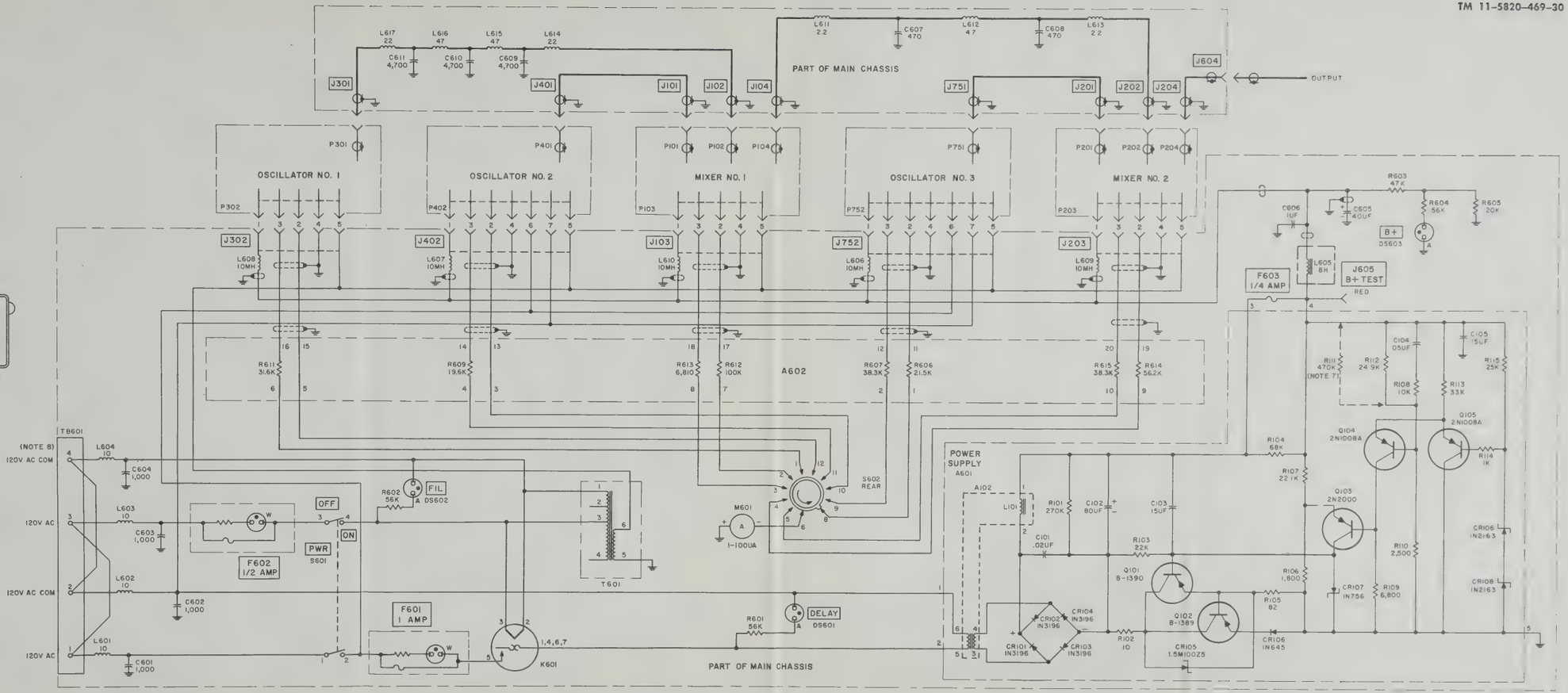
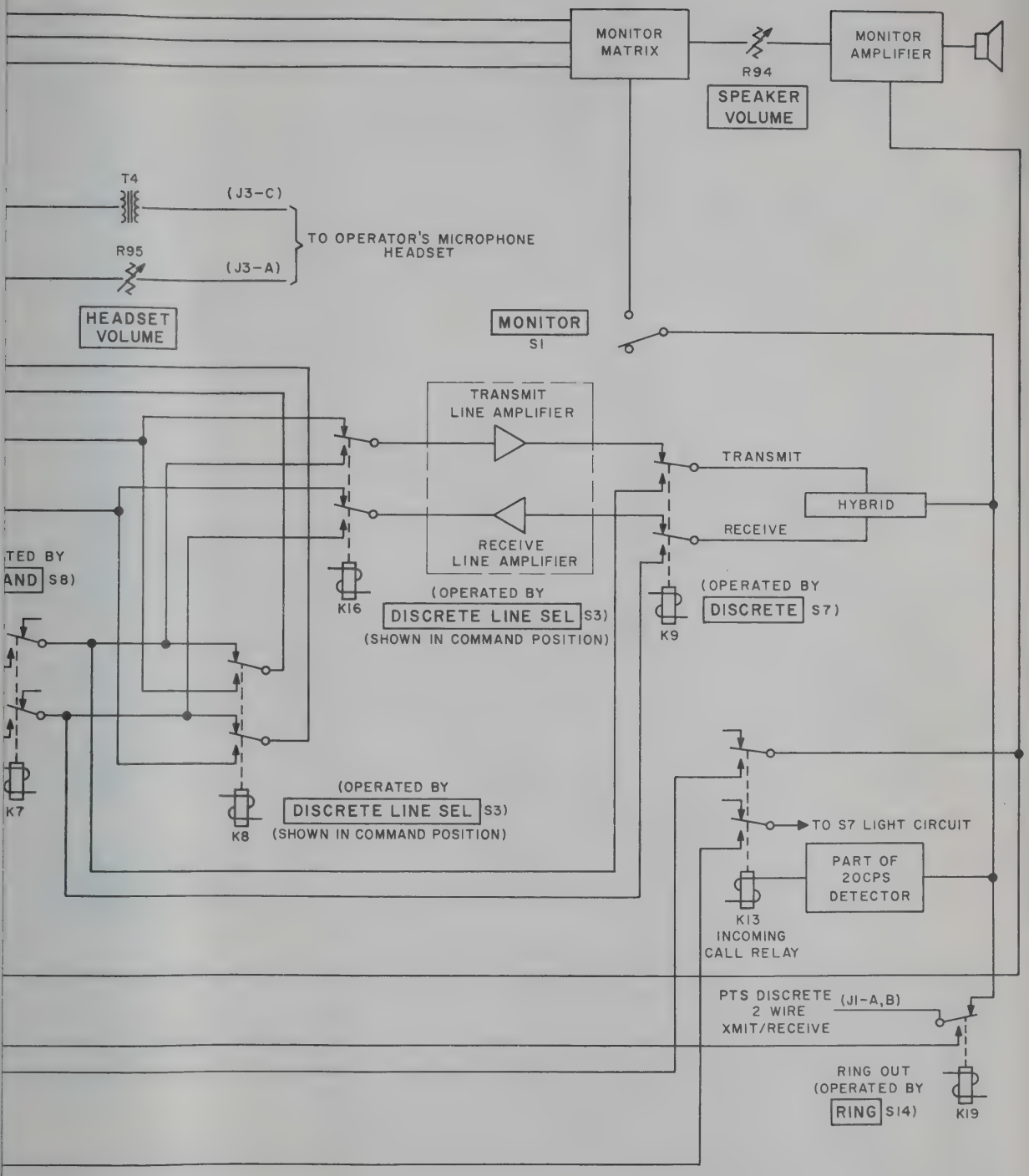


Figure 178. Electrical Frequency Synthesizer 0-937/TRC-80, main frame, schematic diagram.



TM5820-469-30-58

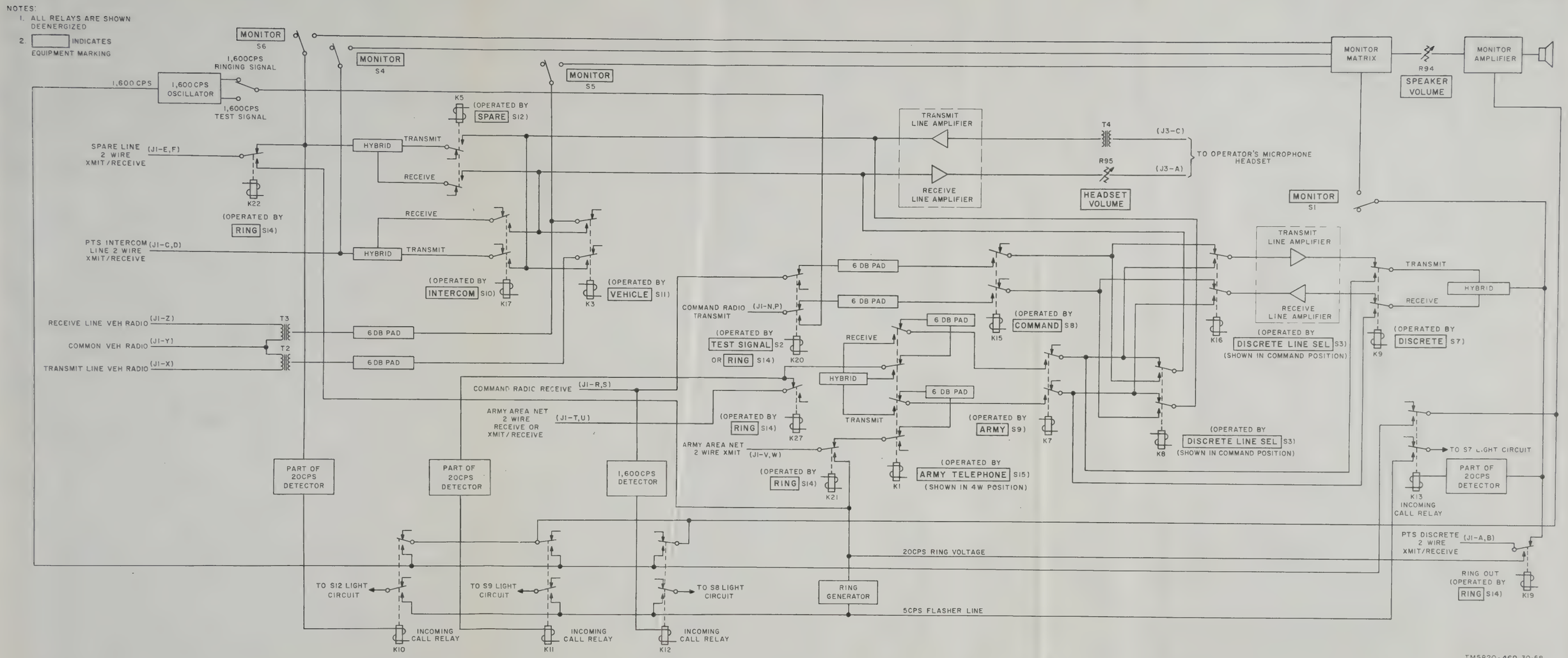
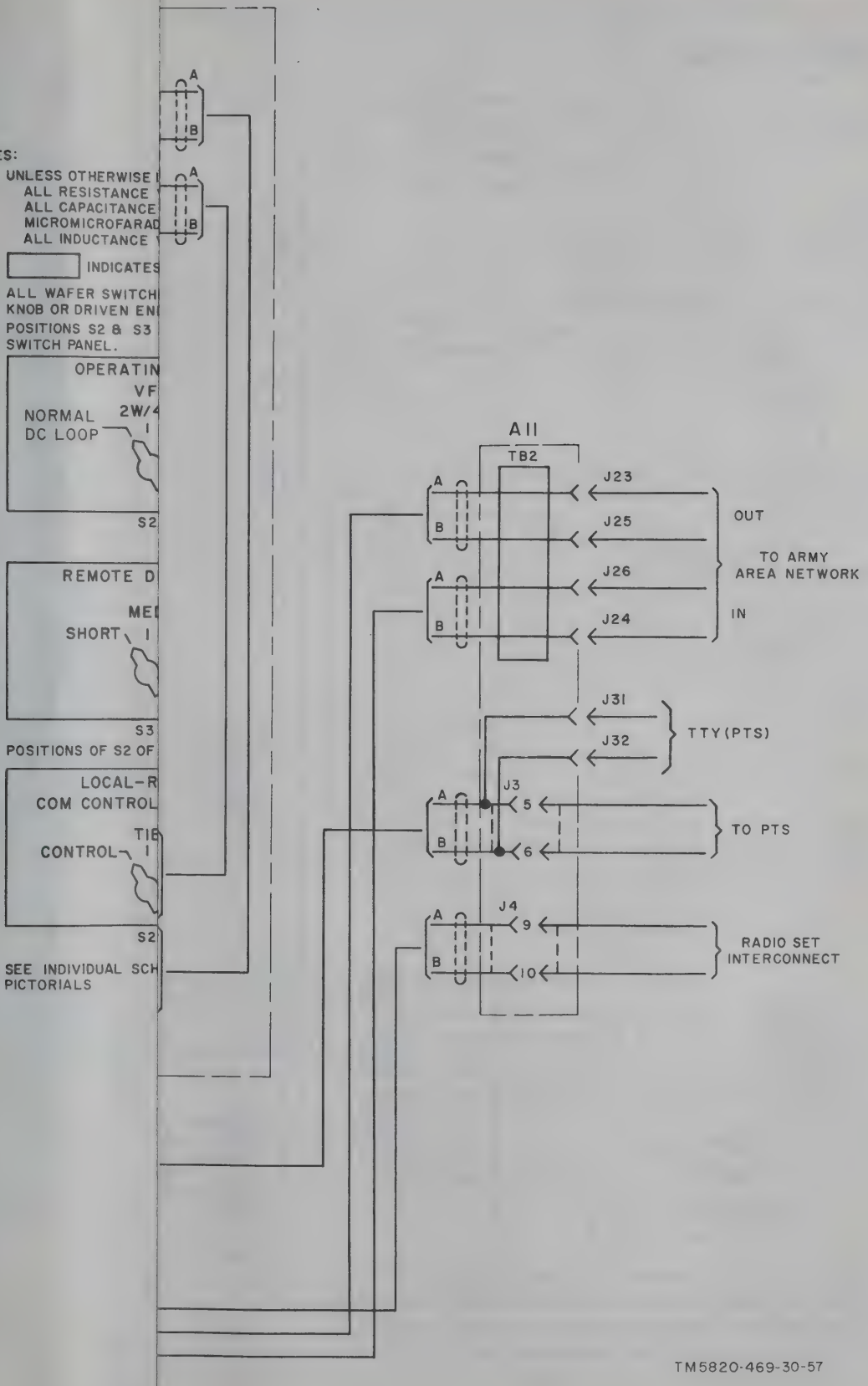


Figure 179. Control panel voice cirluits, functional diagram.

NOTES:

1. UNLESS OTHERWISE I
   ALL RESISTANCE
   ALL CAPACITANCE
   MICROMICROFARAD
   ALL INDUCTANCE
2. [ ] INDICATES
3. ALL WAFER SWITCH
   KNOB OR DRIVEN EN
4. POSITIONS S2 & S3
   SWITCH PANEL.
5. POSITIONS OF S2 OF
6. SEE INDIVIDUAL SCH
   PICTORIALS



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NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS.
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. [ ] INDICATES EQUIPMENT MARKING
3. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
4. POSITIONS S2 & S3 OF TELETYPEWRITER SWITCH PANEL.

OPERATING MODE
VF
NORMAL DC LOOP — 2W/4W — LINE TEST
S2

REMOTE DISTANCE
MED
SHORT — LONG
S3

5. POSITIONS OF S2 OF SWITCH PANEL

LOCAL-REMOTE COM CONTROL SELECTOR
TIE
CONTROL — SLAVE
S2

6. SEE INDIVIDUAL SCHEMATICS FOR CONNECTOR PICTORIALS

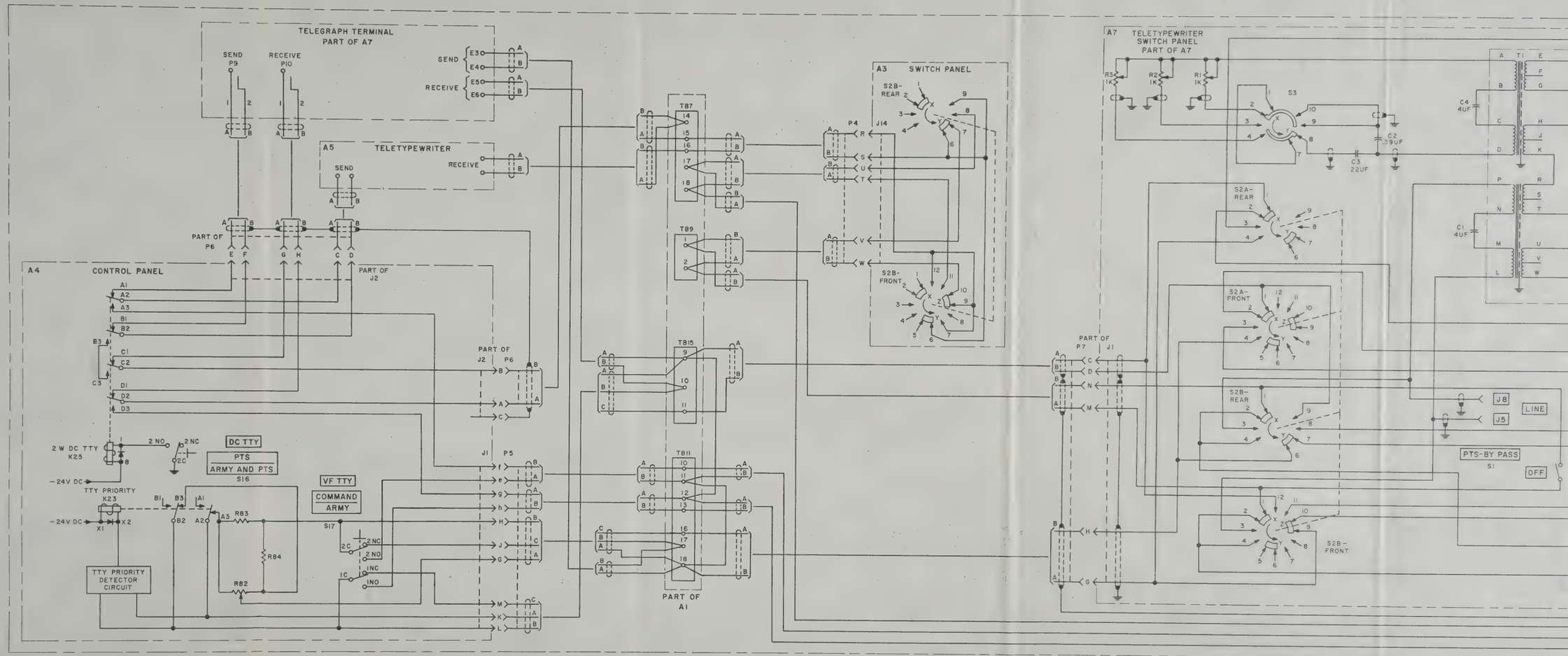
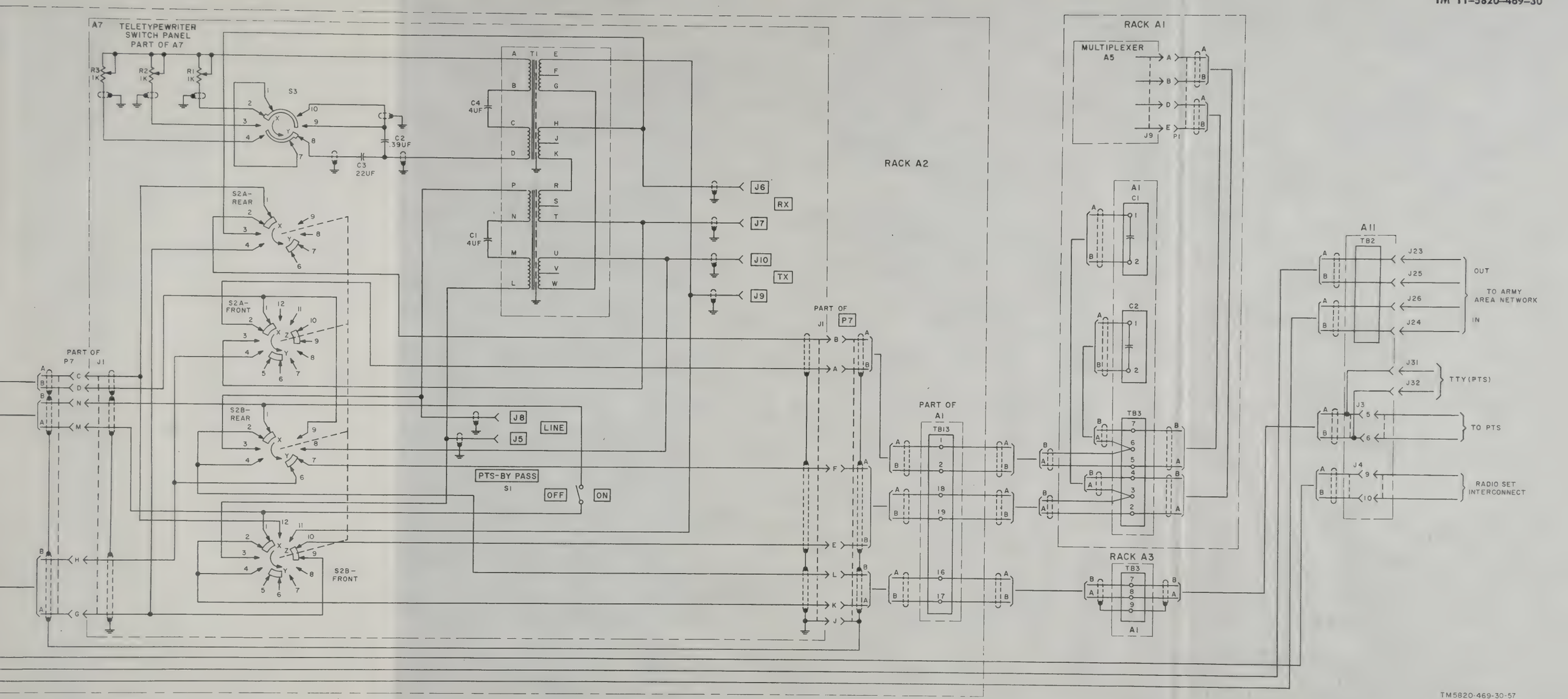
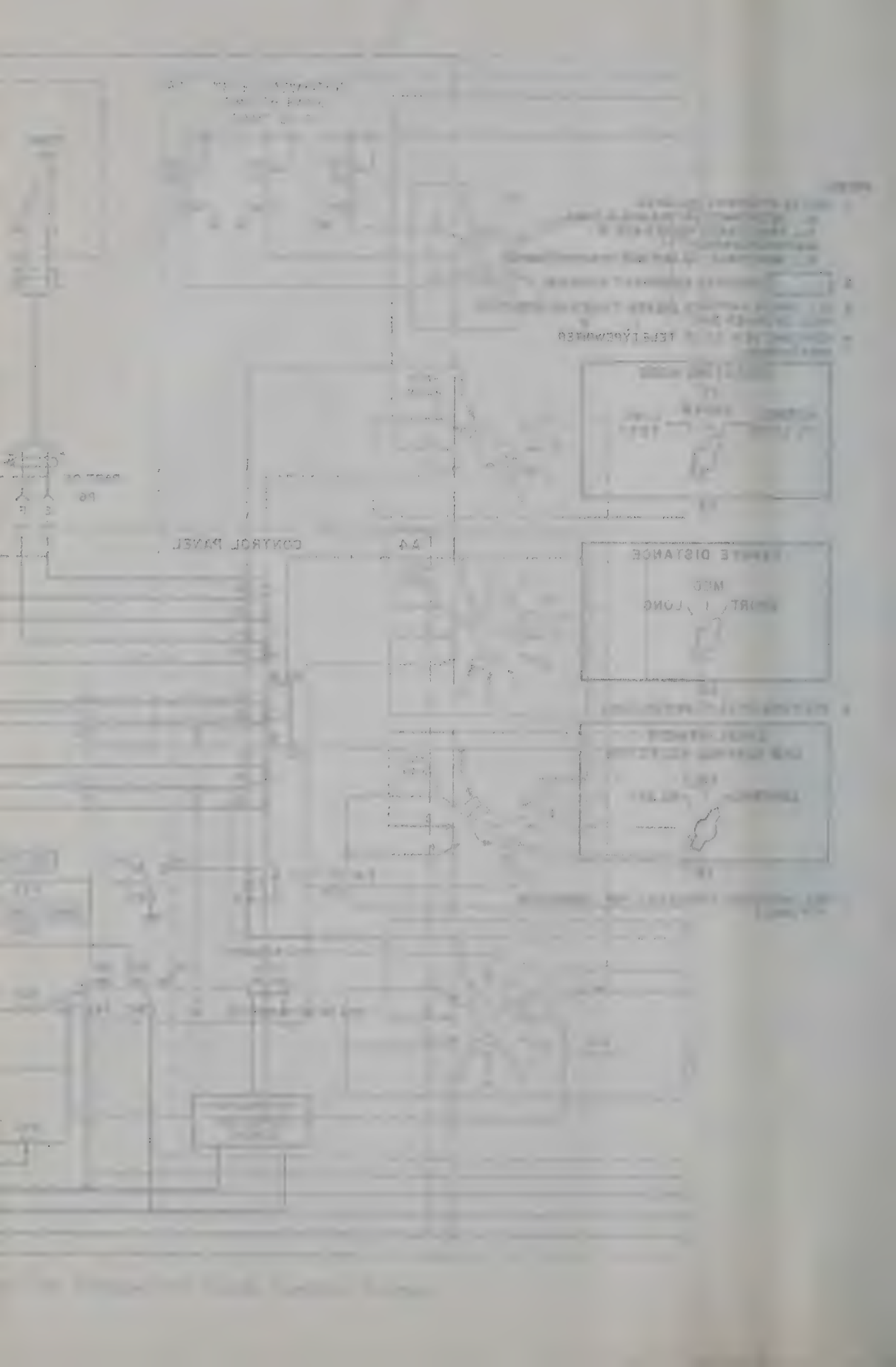


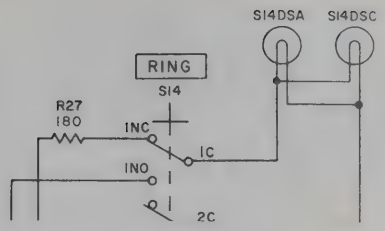
Figure 180. Teletypewriter circuits, functional diagram.



TM5820-469-30-57

re 180. Teletypewriter circuits, functional diagram.




S14DSA
S14DSC
RING
S14
R27
180
INC
1C
INO
2C

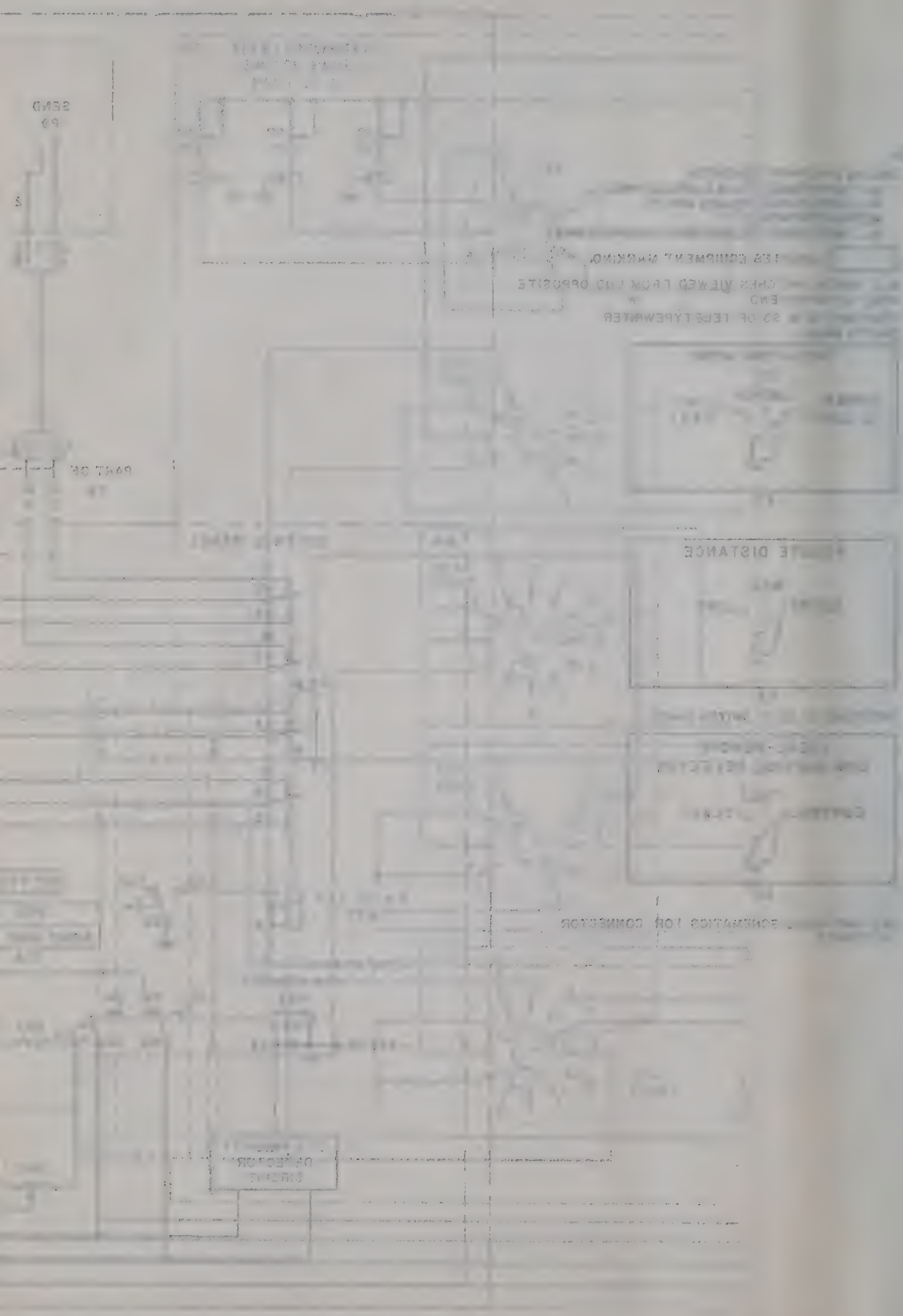
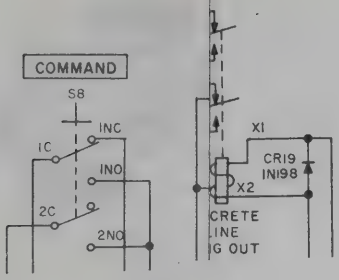
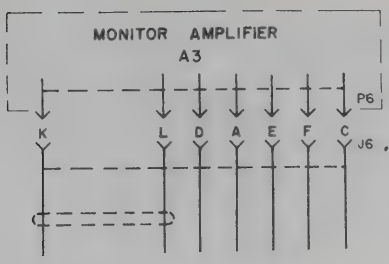


Figure 181. Communication Control Panel SB-1546/TRC-80, complete schematic diagram (part 1 of 2).


COMMAND
S8
INC
1C
1NO
2C
2NO
X1
CR19
1N198
X2
CRETE
INE
G OUT


MONITOR AMPLIFIER
A3
P6
K
L
D
A
E
F
C
J6

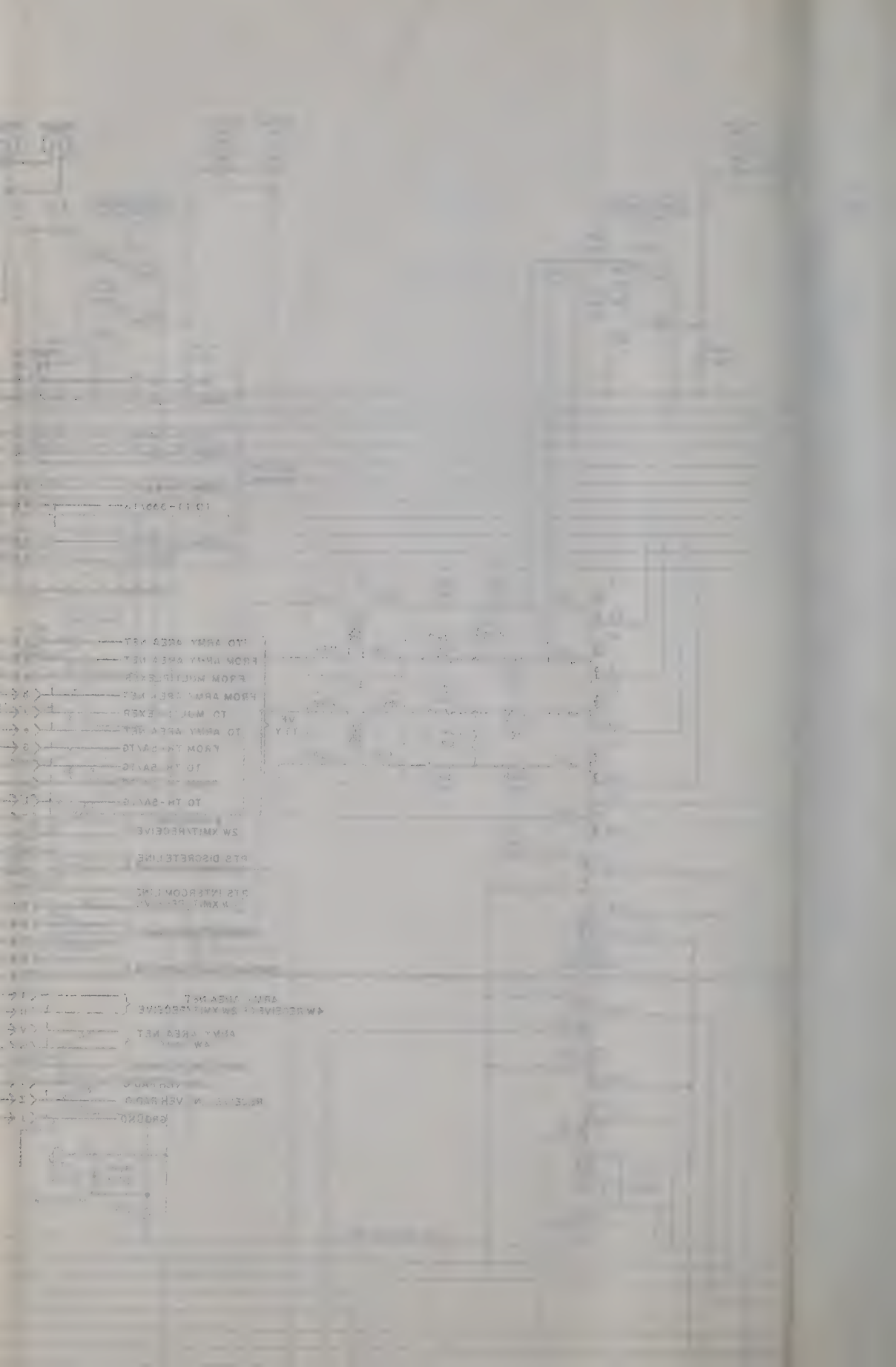
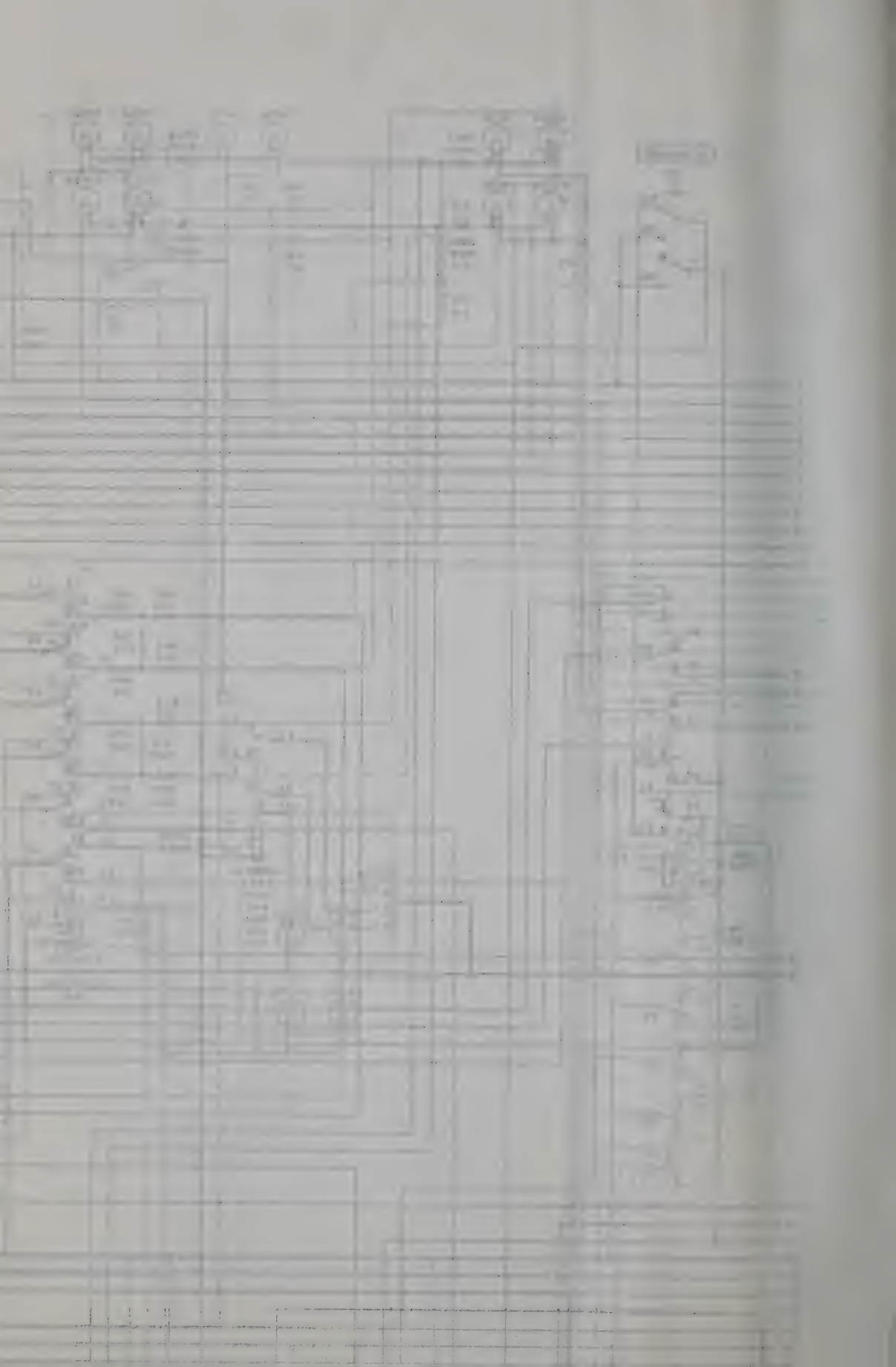
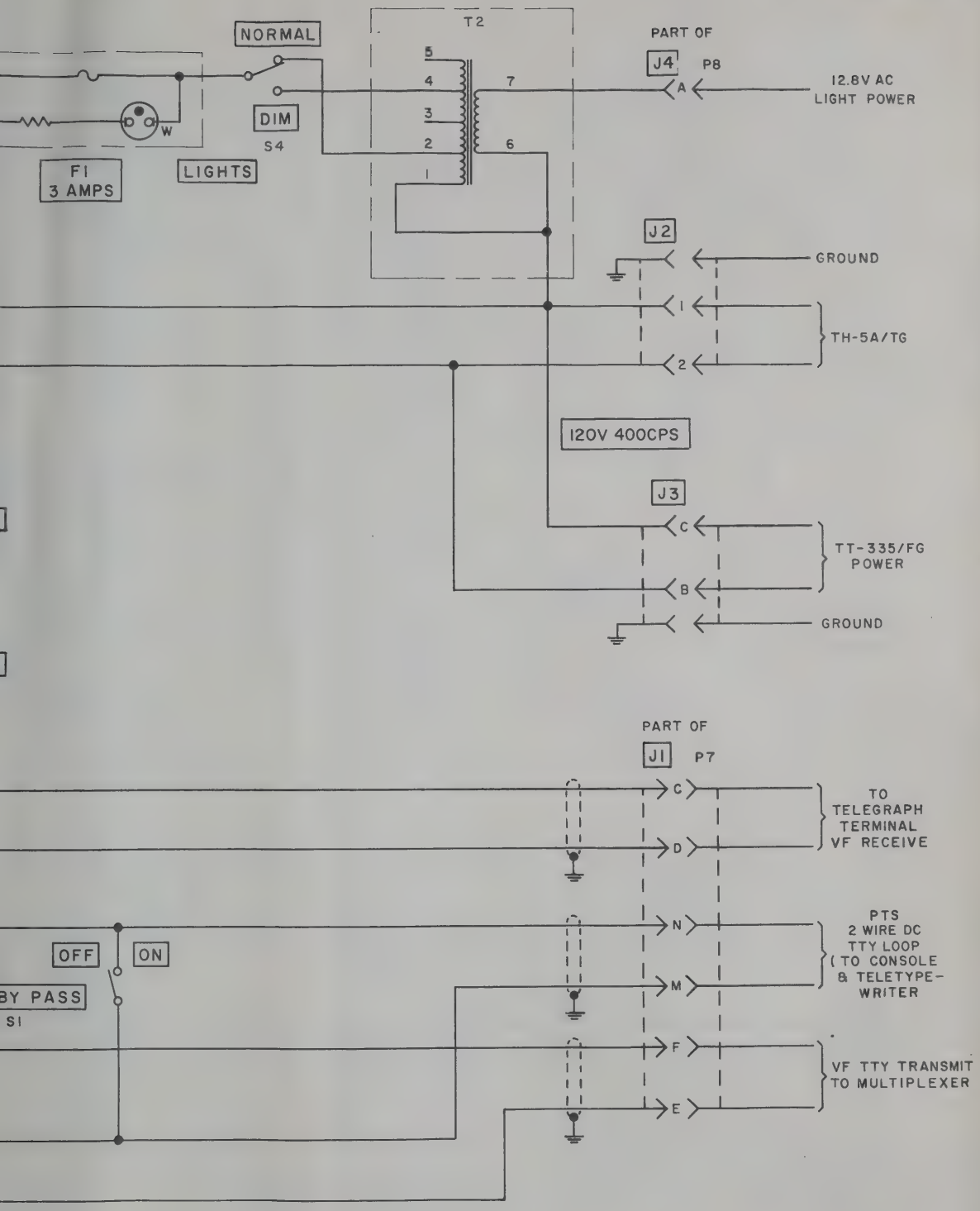
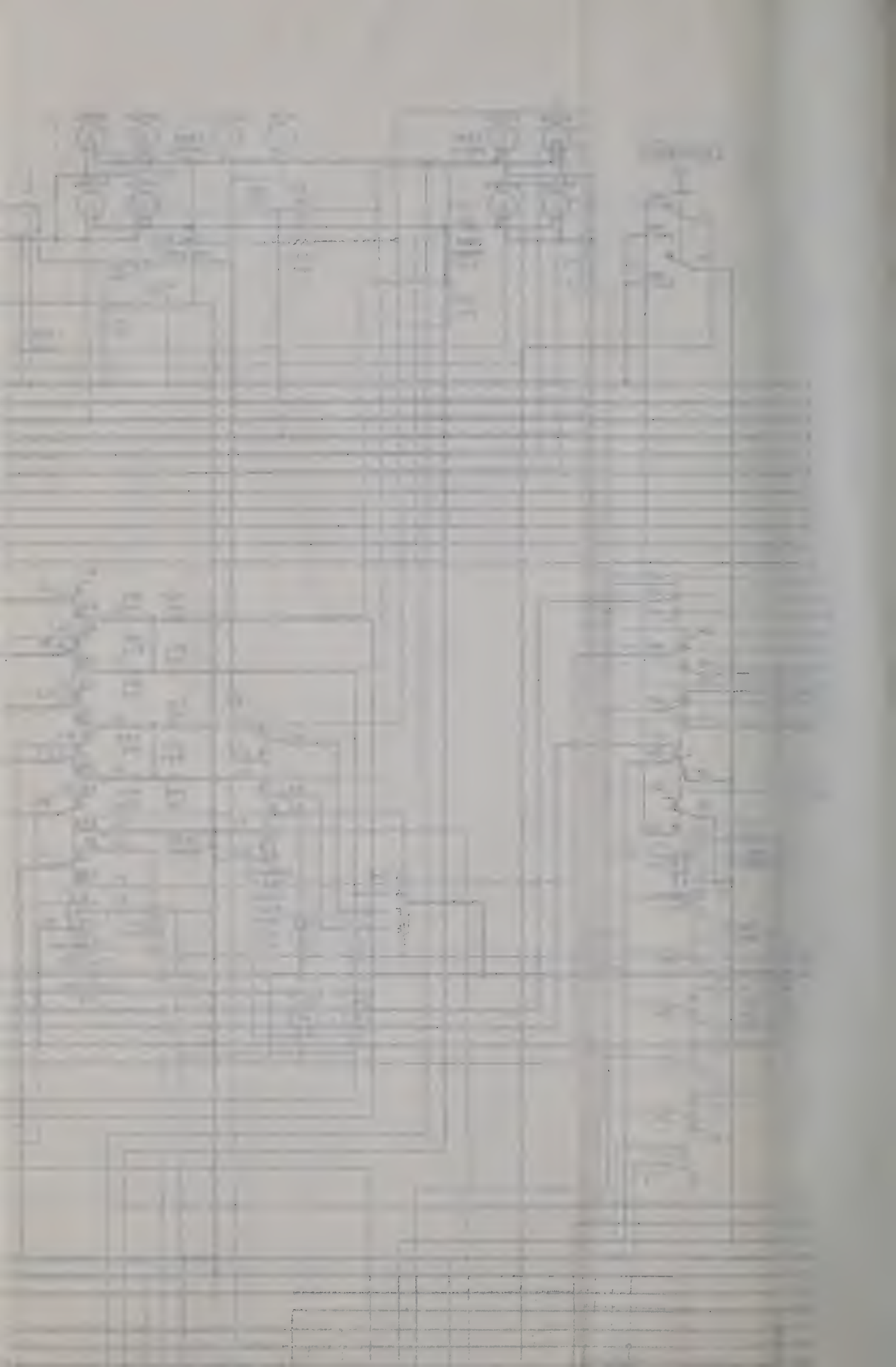


Figure 181. Communication Control Panel SB-1564/TRC-80, complete schematic diagram (part 2 of 2).



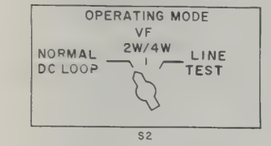


TM5820-469-30-56

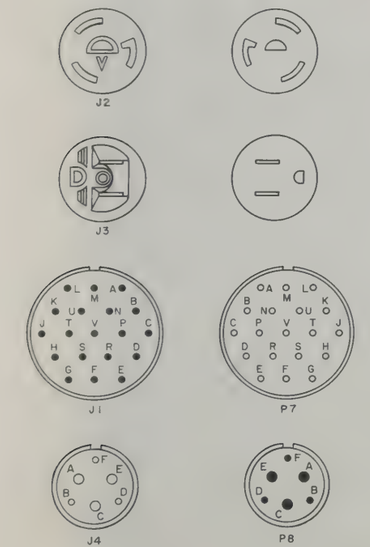


NOTES:

1. UNLESS OTHERWISE INDICATED:
   ALL RESISTANCE VALUES ARE IN OHMS
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS
   ALL INDUCTANCE VALUES ARE IN MICROHENRIES
2. [ ] INDICATES EQUIPMENT MARKING
3. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
4. SWITCH POSITIONS OF S2 AND S3



5. CONNECTOR VIEWED FROM PIN OR RECEPTACLE SIDE



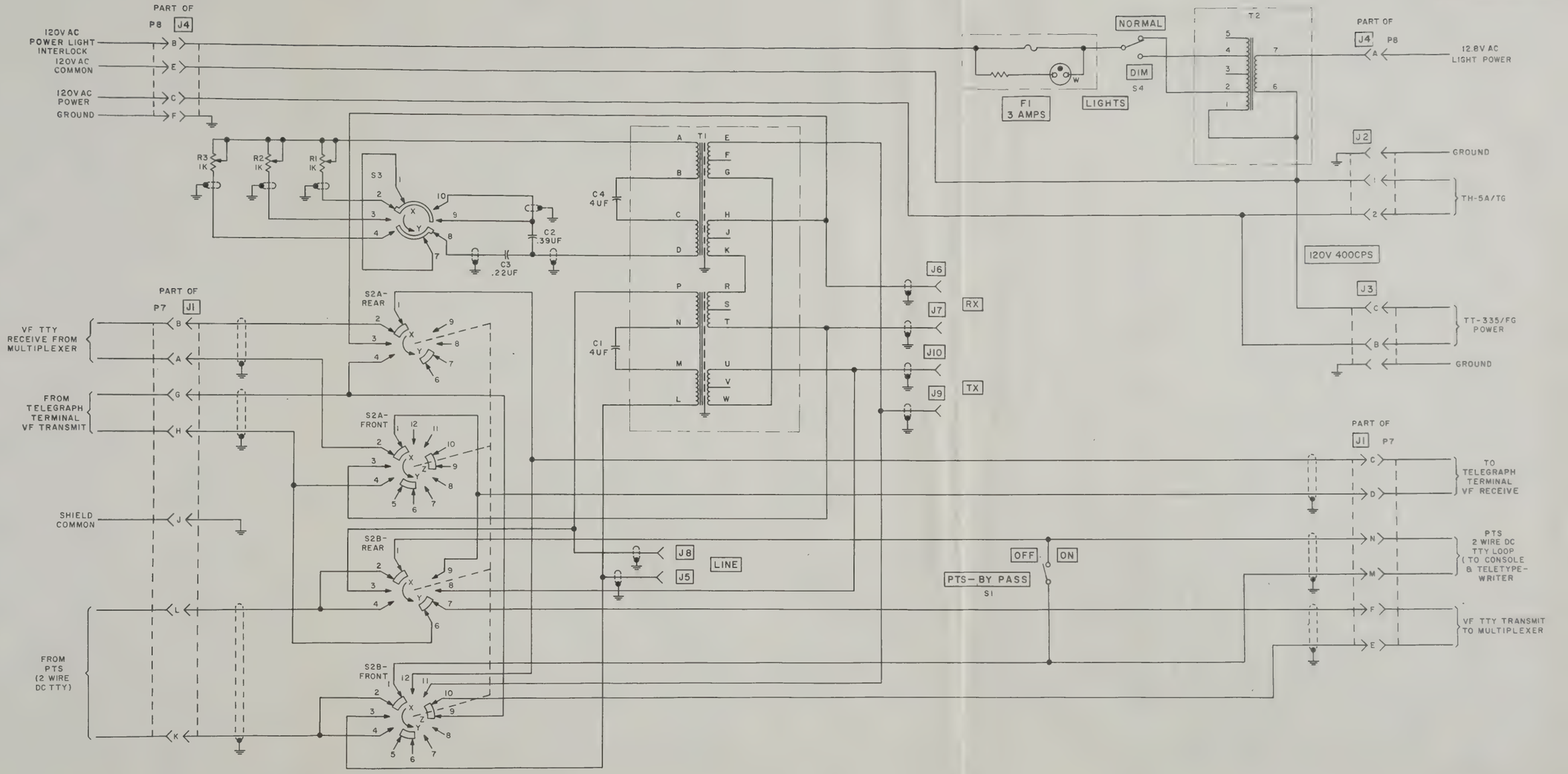
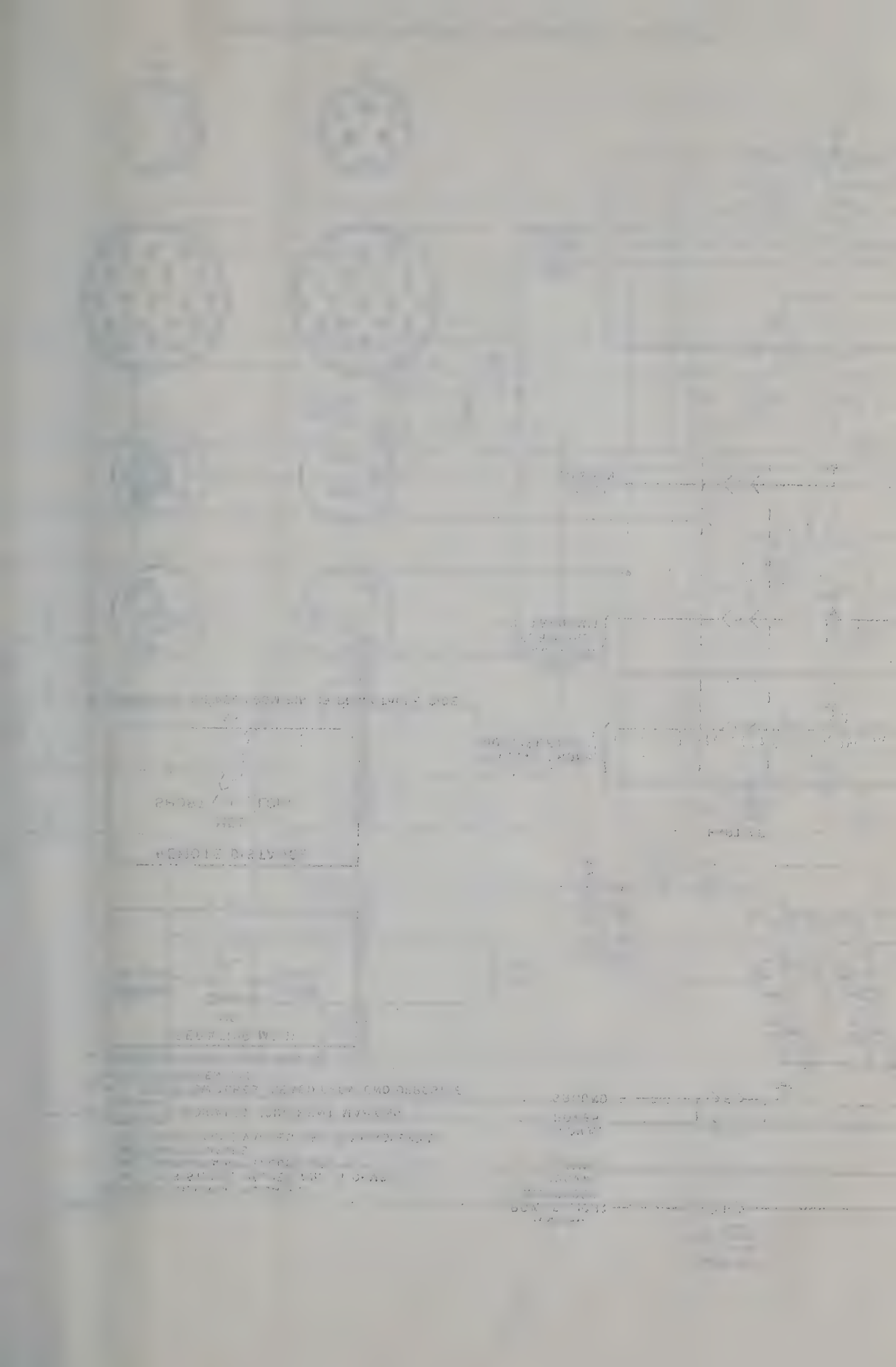
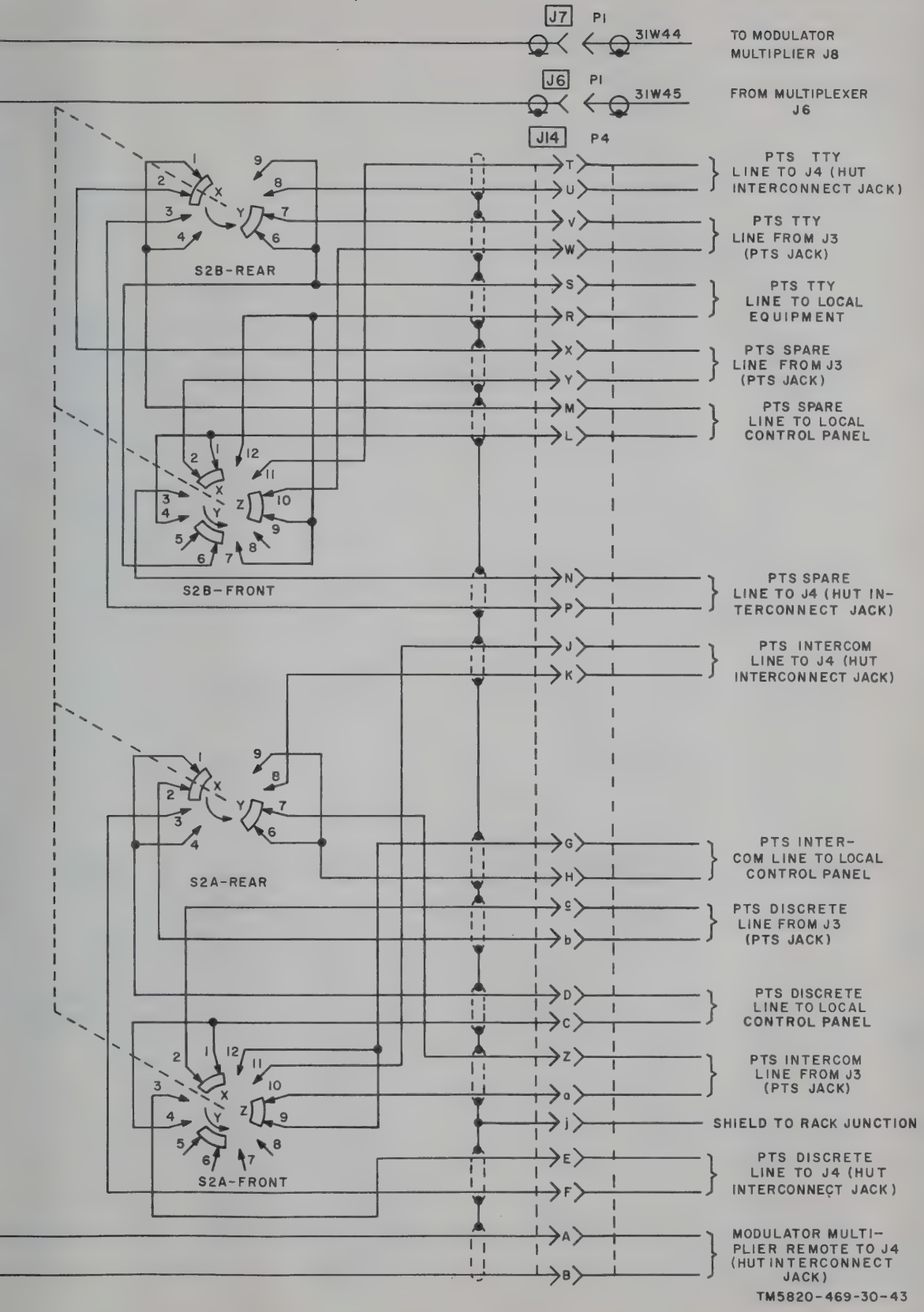


Figure 182. Teletypewriter switch panel, schematic diagram.



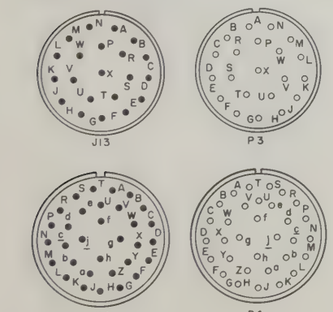

J7 P1
31W44
TO MODULATOR MULTIPLIER J8
J6 P1
31W45
FROM MULTIPLEXER J6
J14 P4
S2B-REAR
S2B-FRONT
S2A-REAR
S2A-FRONT
T
U
V
W
S
R
X
Y
M
L
N
P
J
K
G
H
g
b
D
C
Z
a
j
E
F
A
B
PTS TTY LINE TO J4 (HUT INTERCONNECT JACK)
PTS TTY LINE FROM J3 (PTS JACK)
PTS TTY LINE TO LOCAL EQUIPMENT
PTS SPARE LINE FROM J3 (PTS JACK)
PTS SPARE LINE TO LOCAL CONTROL PANEL
PTS SPARE LINE TO J4 (HUT INTERCONNECT JACK)
PTS INTERCOM LINE TO J4 (HUT INTERCONNECT JACK)
PTS INTER-COM LINE TO LOCAL CONTROL PANEL
PTS DISCRETE LINE FROM J3 (PTS JACK)
PTS DISCRETE LINE TO LOCAL CONTROL PANEL
PTS INTERCOM LINE FROM J3 (PTS JACK)
SHIELD TO RACK JUNCTION
PTS DISCRETE LINE TO J4 (HUT INTERCONNECT JACK)
MODULATOR MULTI-PLIER REMOTE TO J4 (HUT INTERCONNECT JACK)
TM5820-469-30-43

NOTES:
1. UNLESS OTHERWISE INDICATED: ALL RESISTANCE VALUES ARE IN OHMS
2. THE THREE RACK ON-OFF TOGGLE SWITCHES ARE CONNECTED TOGETHER WITH A REMOVABLE LINKAGE
3. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE KNOB OR DRIVEN END
4. [ ] INDICATES EQUIPMENT MARKING
5. SWITCH POSITIONS OF S1 AND S2

DEMULT - MULT-MOD SELECTOR S1
PARALLEL
LOCAL / REMOTE

LOCAL - REMOTE COM CONTROL SELECTOR S2
TIE
CONTROL / SLAVE

6. CONNECTORS VIEWED FROM PIN OR RECEPTACLE SIDE



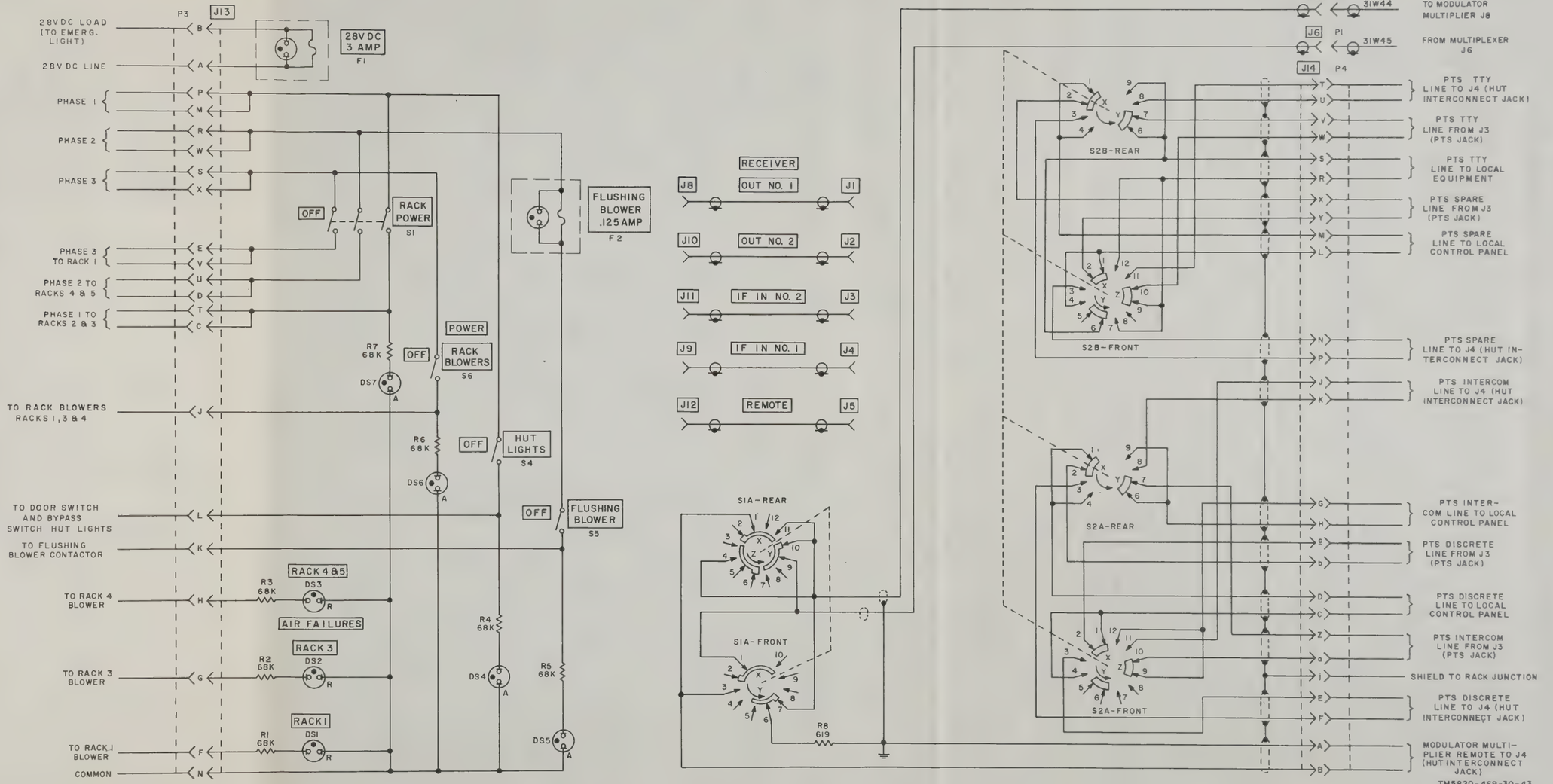
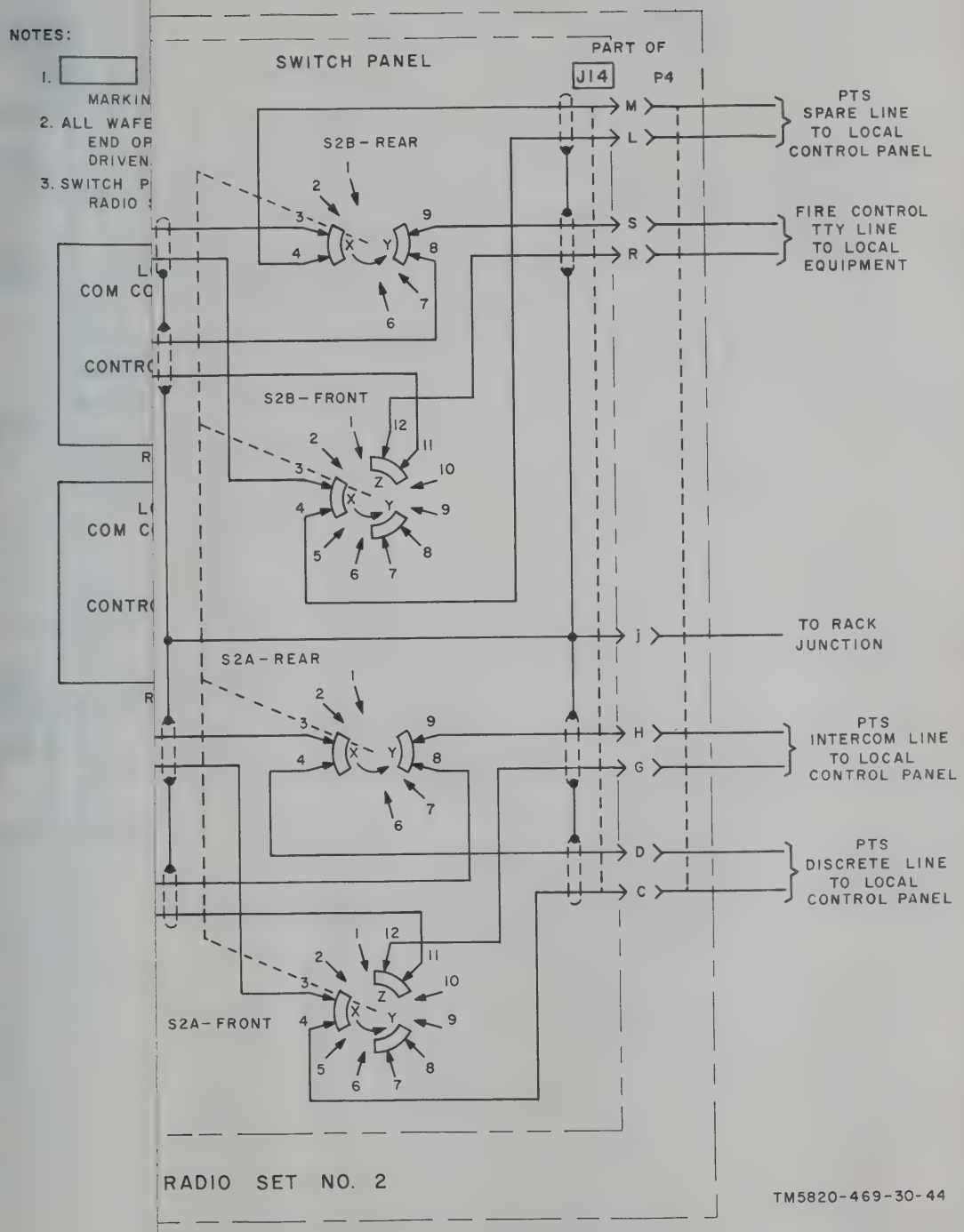
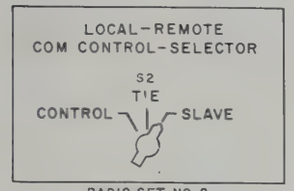


Figure 183. Power Distribution Panel SB-1565/TRC-80, complete schematic diagram.

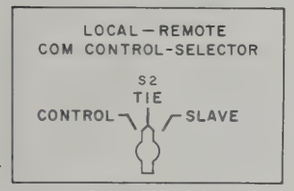

NOTES:
1.
MARKIN
2. ALL WAFE
END OP
DRIVEN.
3. SWITCH P
RADIO
SWITCH PANEL
PART OF
J14
P4
S2B - REAR
S2B - FRONT
S2A - REAR
S2A - FRONT
M
L
S
R
J
H
G
D
C
PTS
SPARE LINE
TO LOCAL
CONTROL PANEL
FIRE CONTROL
TTY LINE
TO LOCAL
EQUIPMENT
TO RACK
JUNCTION
PTS
INTERCOM LINE
TO LOCAL
CONTROL PANEL
PTS
DISCRETE LINE
TO LOCAL
CONTROL PANEL
RADIO SET NO. 2
TM5820-469-30-44

NOTES:

1. [ ] INDICATES EQUIPMENT MARKING
2. ALL WAFER SWITCHES VIEWED FROM END OPPOSITE THE KNOB OR DRIVEN END
3. SWITCH POSITIONS OF S2 FOR BOTH RADIO SETS



RADIO SET NO. 2



RADIO SET NO. 1

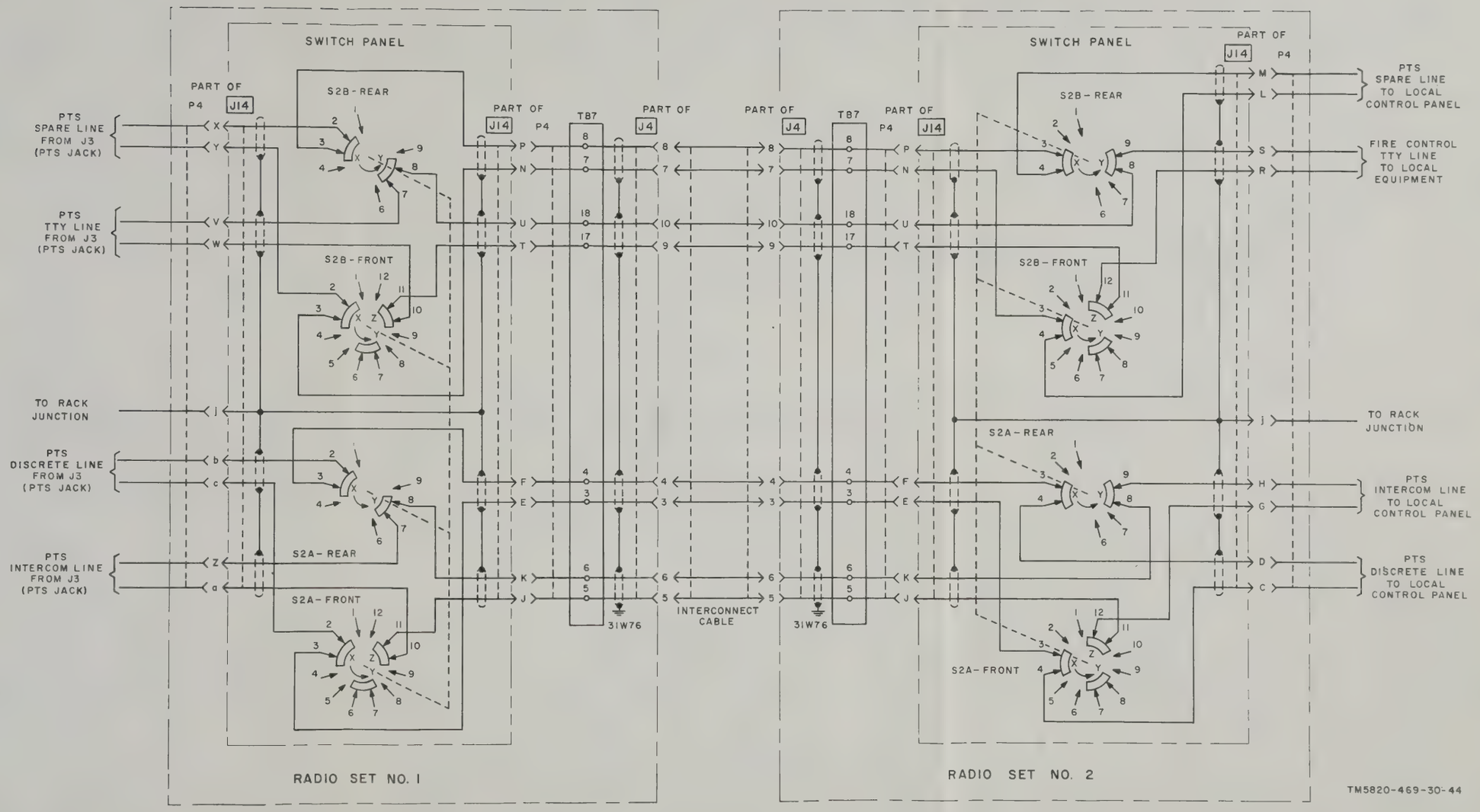
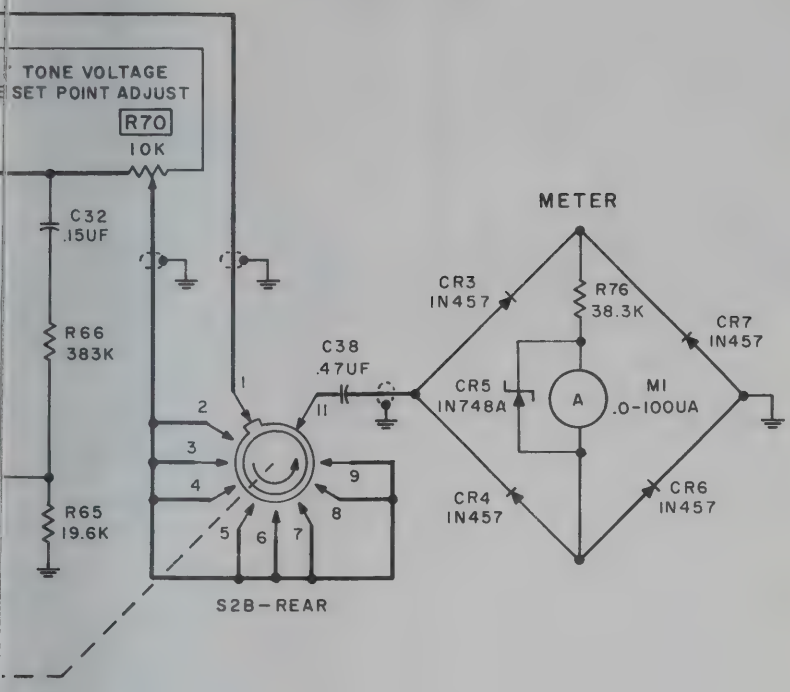
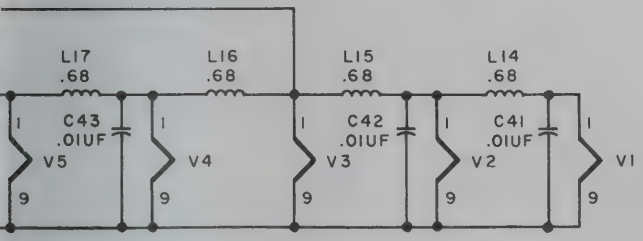
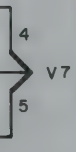


Figure 184. Selector switch S2 (part of Power Distribution Panel SB-1565/TRC-80) with radio set No. 2 as control unit, simplified schematic diagram.


TONE VOLTAGE
SET POINT ADJUST
R70
10K
C32
.15UF
R66
383K
R65
19.6K
C38
.47UF
METER
CR3
IN457
R76
38.3K
CR7
IN457
CR5
IN748A
A
MI
.0-100UA
CR4
IN457
CR6
IN457
S2B-REAR


L17
.68
L16
.68
L15
.68
L14
.68
C43
.01UF
C42
.01UF
C41
.01UF
V5
V4
V3
V2
V1


V7

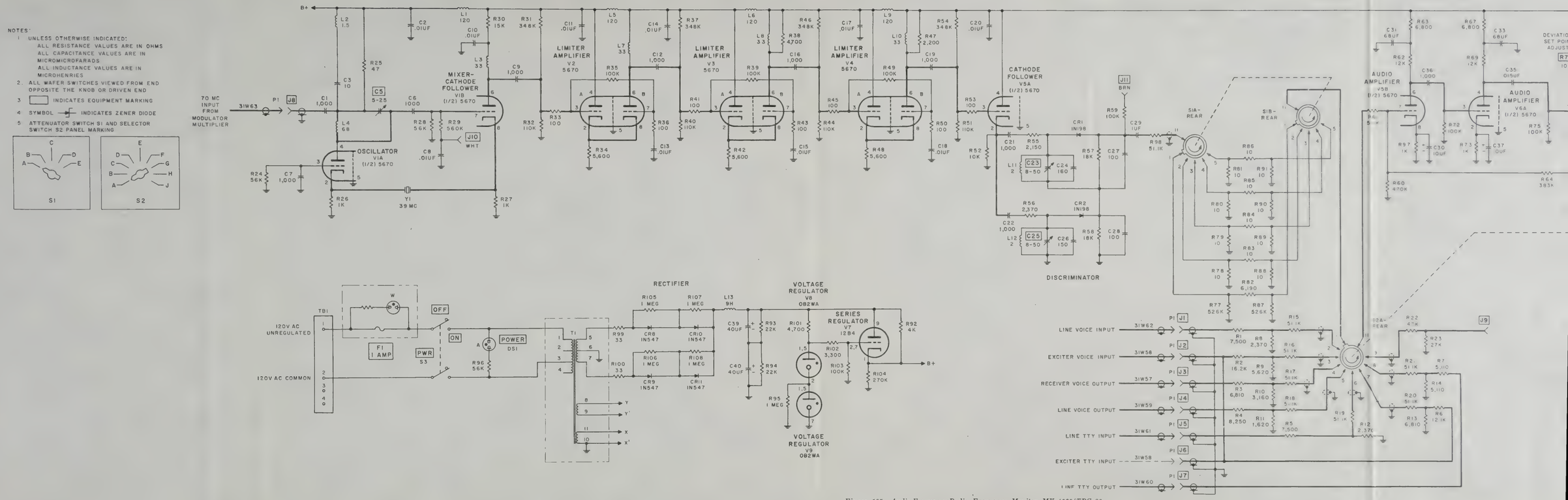


Figure 185. Audio-Frequency-Radio Frequency Monitor MX-4039/TRC-80, complete schematic diagram.

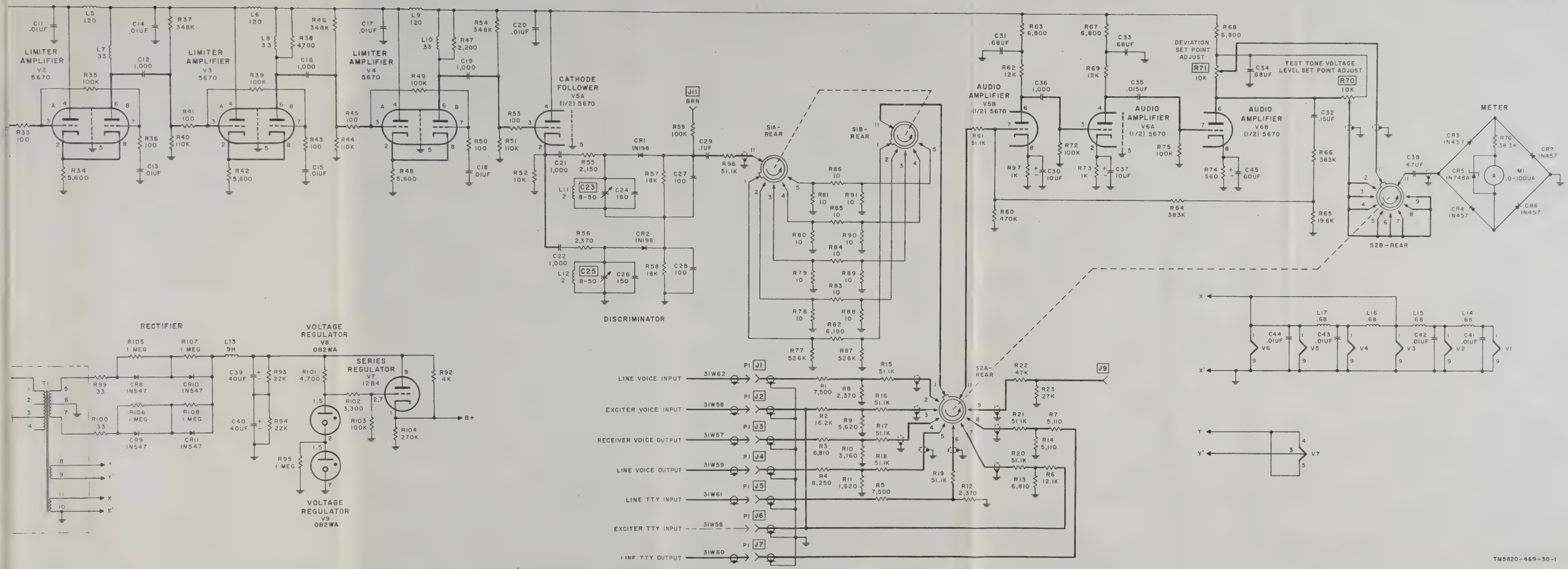
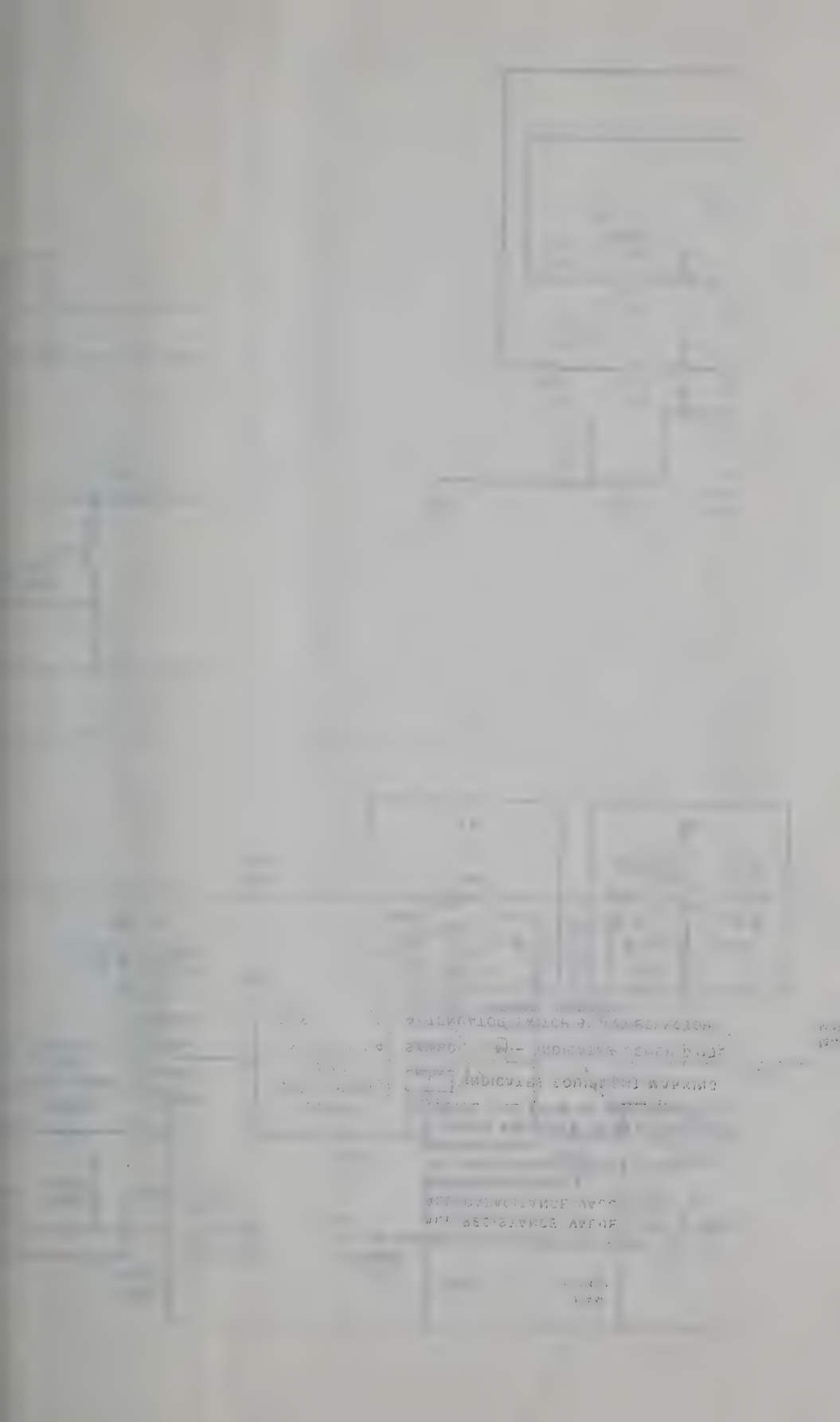
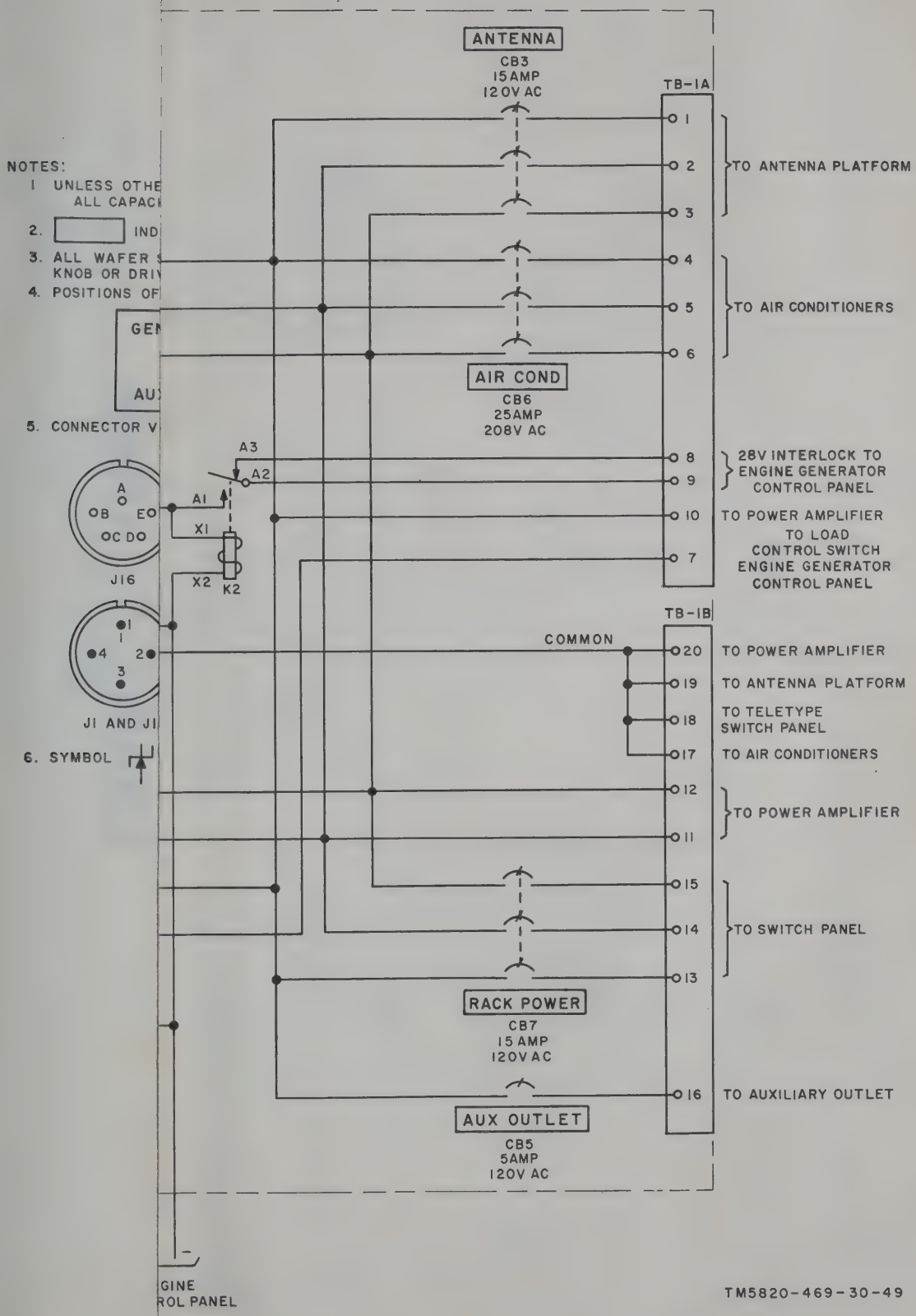


Figure 185. Audio-Frequency-Radio Frequency Monitor MX-4039/TRC-80, complete schematic diagram.

TM5820-469-30-1




ANTENNA
CB3
15AMP
120V AC
TB-1A
1
2
3
TO ANTENNA PLATFORM
4
5
6
TO AIR CONDITIONERS
AIR COND
CB6
25AMP
208V AC
A3
A2
A1
X1
X2
K2
8
9
28V INTERLOCK TO ENGINE GENERATOR CONTROL PANEL
10
TO POWER AMPLIFIER
7
TO LOAD CONTROL SWITCH ENGINE GENERATOR CONTROL PANEL
J16
TB-1B
COMMON
20
TO POWER AMPLIFIER
19
TO ANTENNA PLATFORM
18
TO TELETYPE SWITCH PANEL
17
TO AIR CONDITIONERS
J1 AND J1
12
11
TO POWER AMPLIFIER
15
14
TO SWITCH PANEL
13
RACK POWER
CB7
15 AMP
120V AC
16
TO AUXILIARY OUTLET
AUX OUTLET
CB5
5AMP
120V AC
NOTES:
1 UNLESS OTHE
ALL CAPACI
2. IND
3. ALL WAFER
KNOB OR DRI
4. POSITIONS OF
GE
AU
5. CONNECTOR V
6. SYMBOL
GINE
ROL PANEL
TM5820-469-30-49

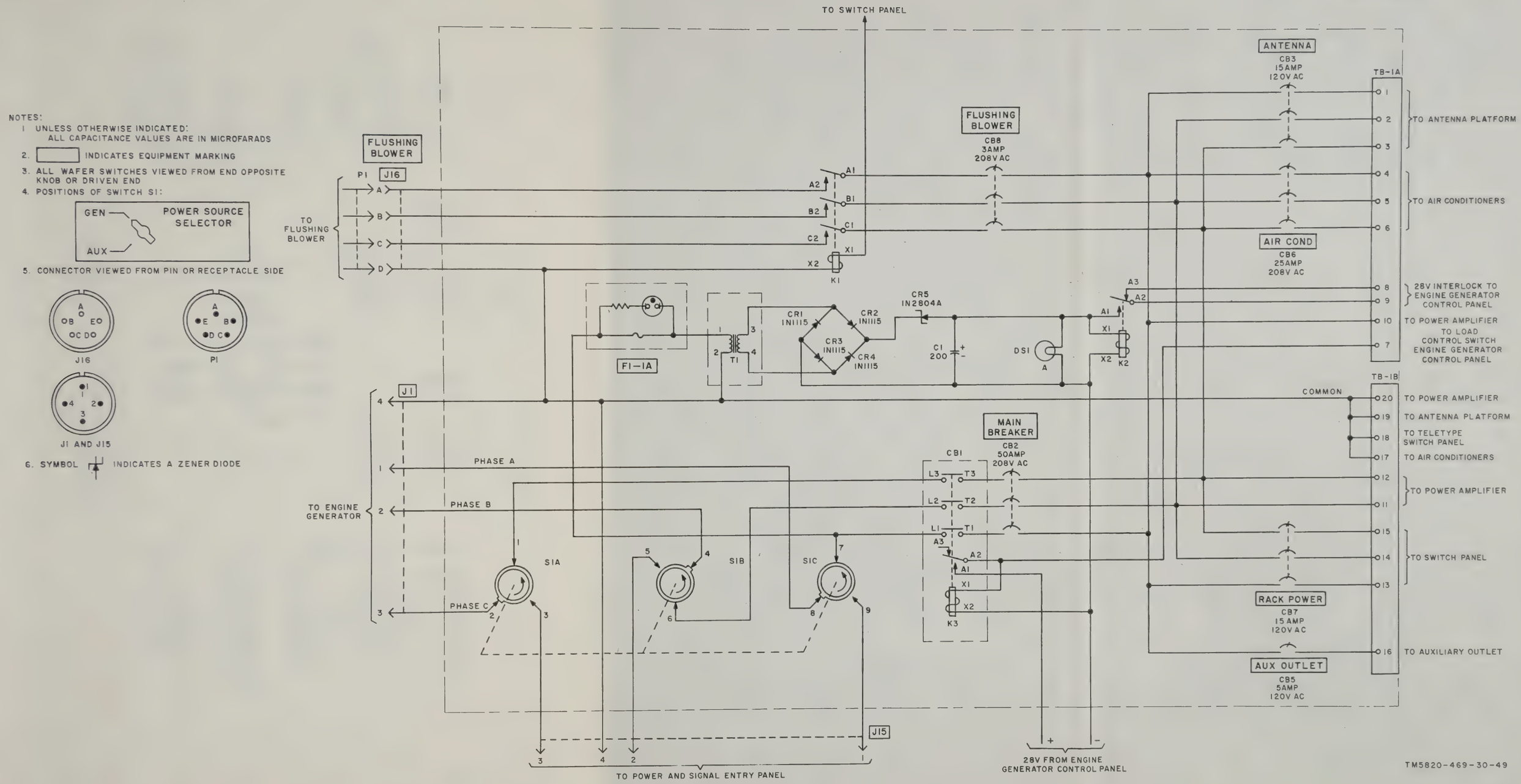
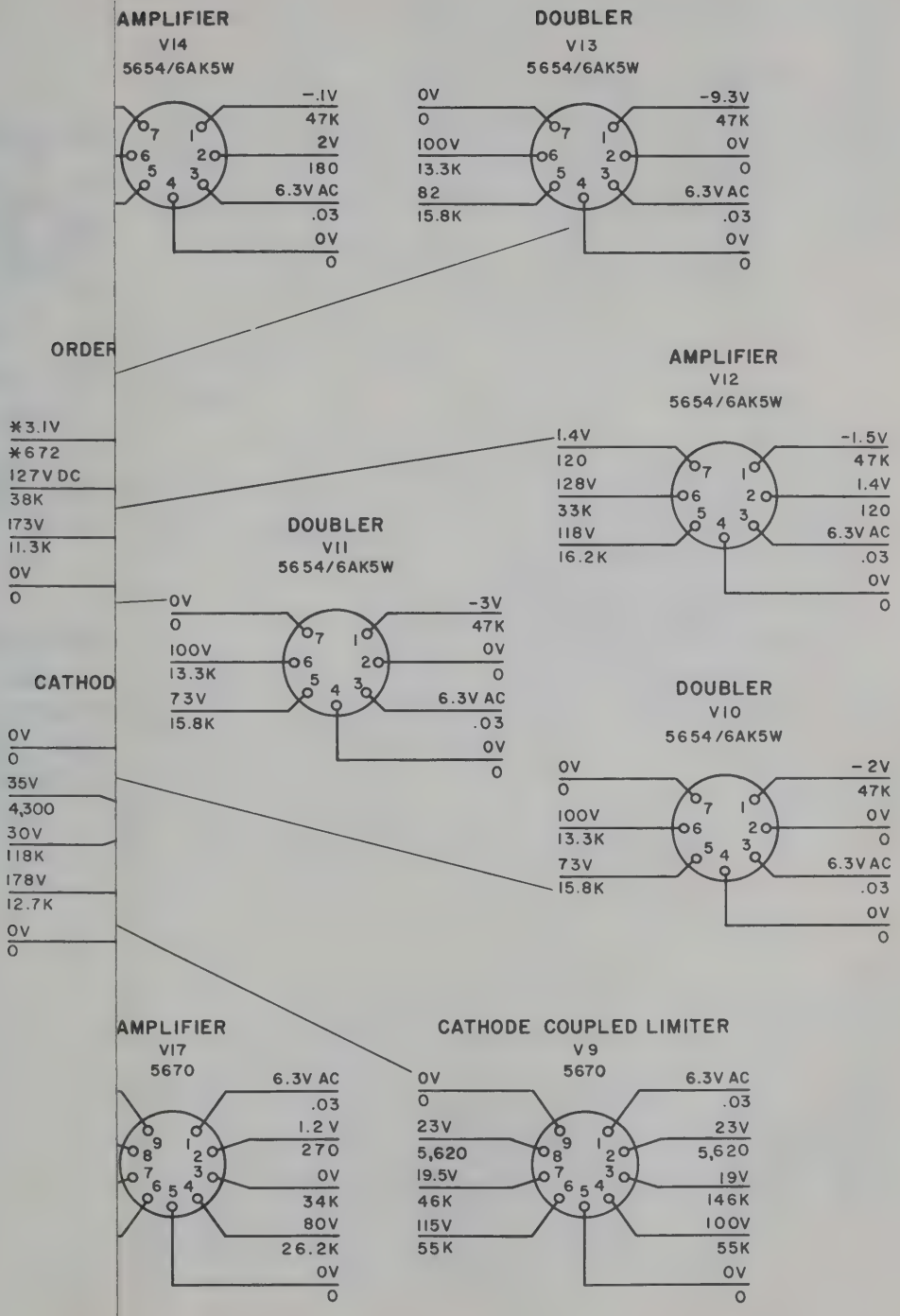
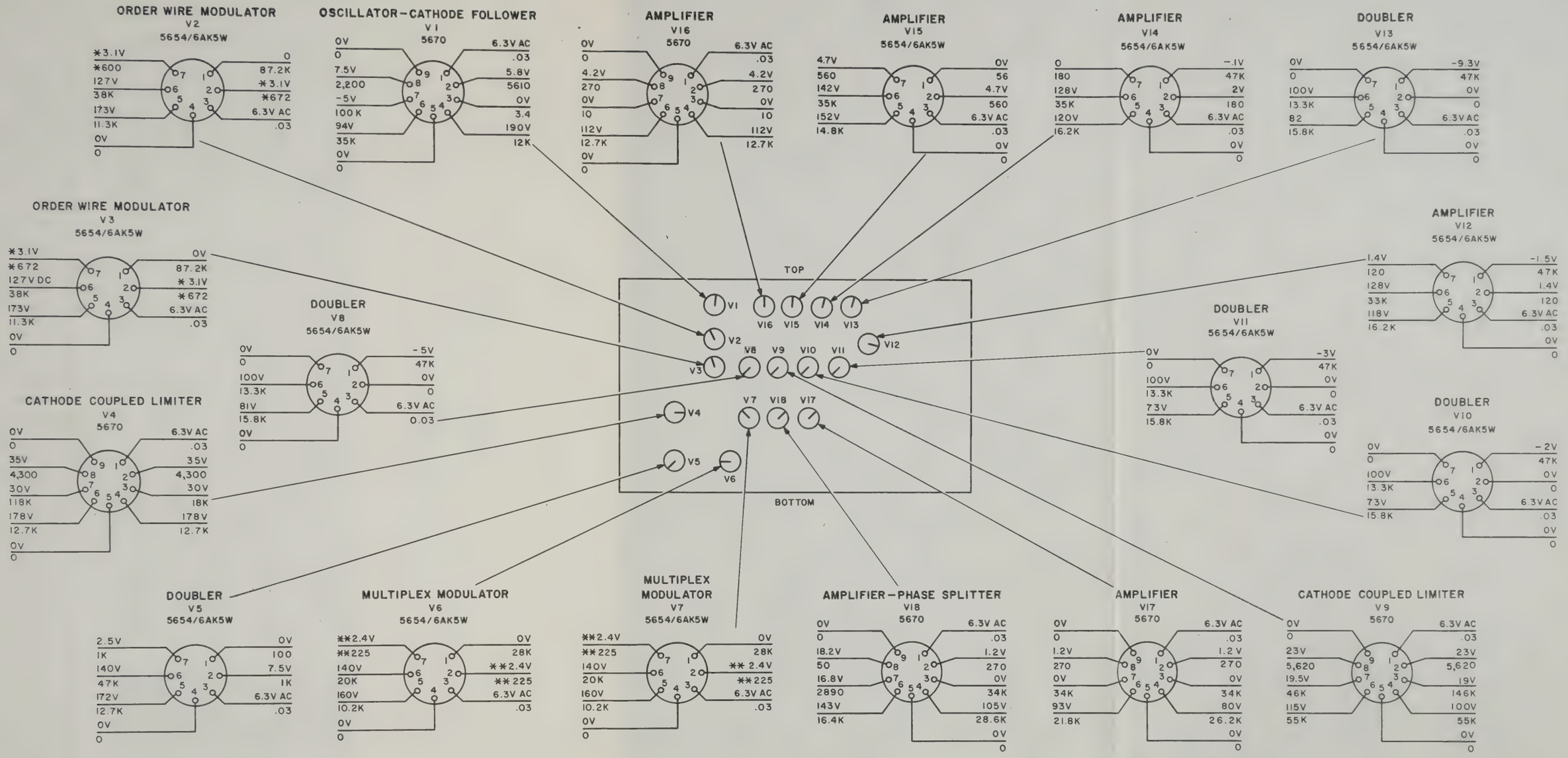


Figure 186. Circuit breaker panel, complete schematic diagram.



TM5820-469-30-51



NOTES:

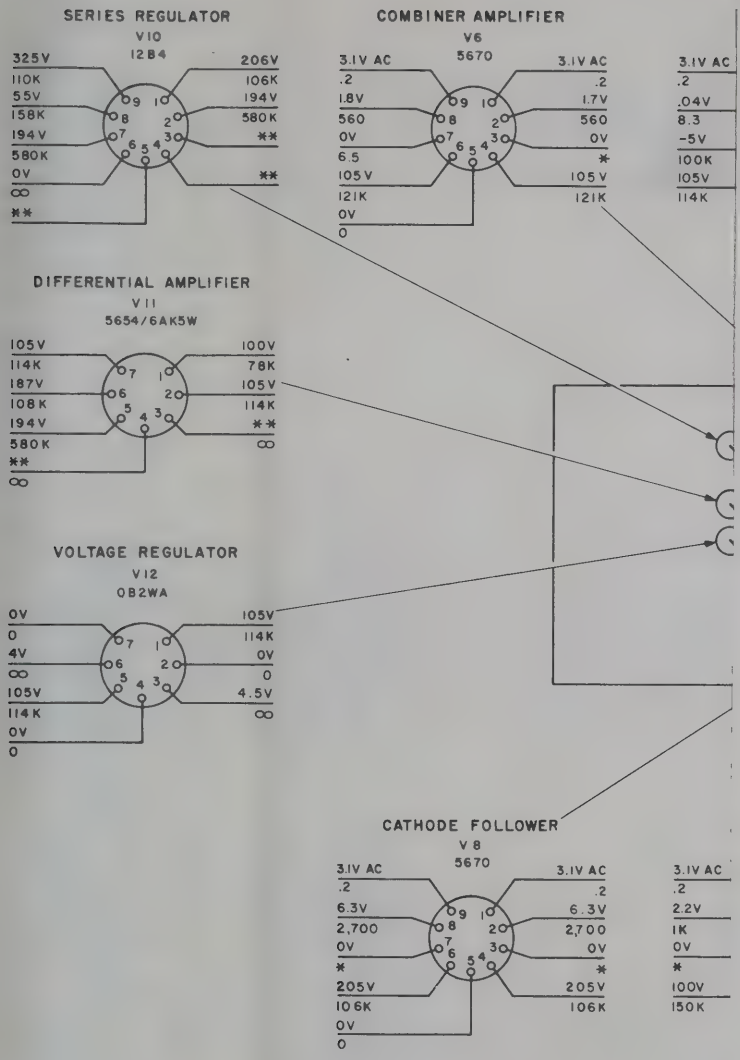
1. VOLTAGES MEASURED TO GROUND WITH A VACUUM TUBE VOLTMETER (ME-26/U)
2. VOLTAGE READINGS WERE MADE WITH 120 VOLT AC PRIMARY POWER APPLIED TO TB1 AND WITH NO CONNECTIONS TO J8 AND J9 ON BACK OF THE UNIT
3. FOR RESISTANCE MEASUREMENTS ONLY, DISCONNECT ALL EXTERNAL PLUGS AND USE A 20,000 OHMS-PER-VOLT METER
4. FINAL VOLTAGE READINGS ABOVE THE LINES AND RESISTANCE READINGS BELOW THE LINES

* DEPENDS ON SETTING OF R20

** DEPENDS ON SETTING OF R42

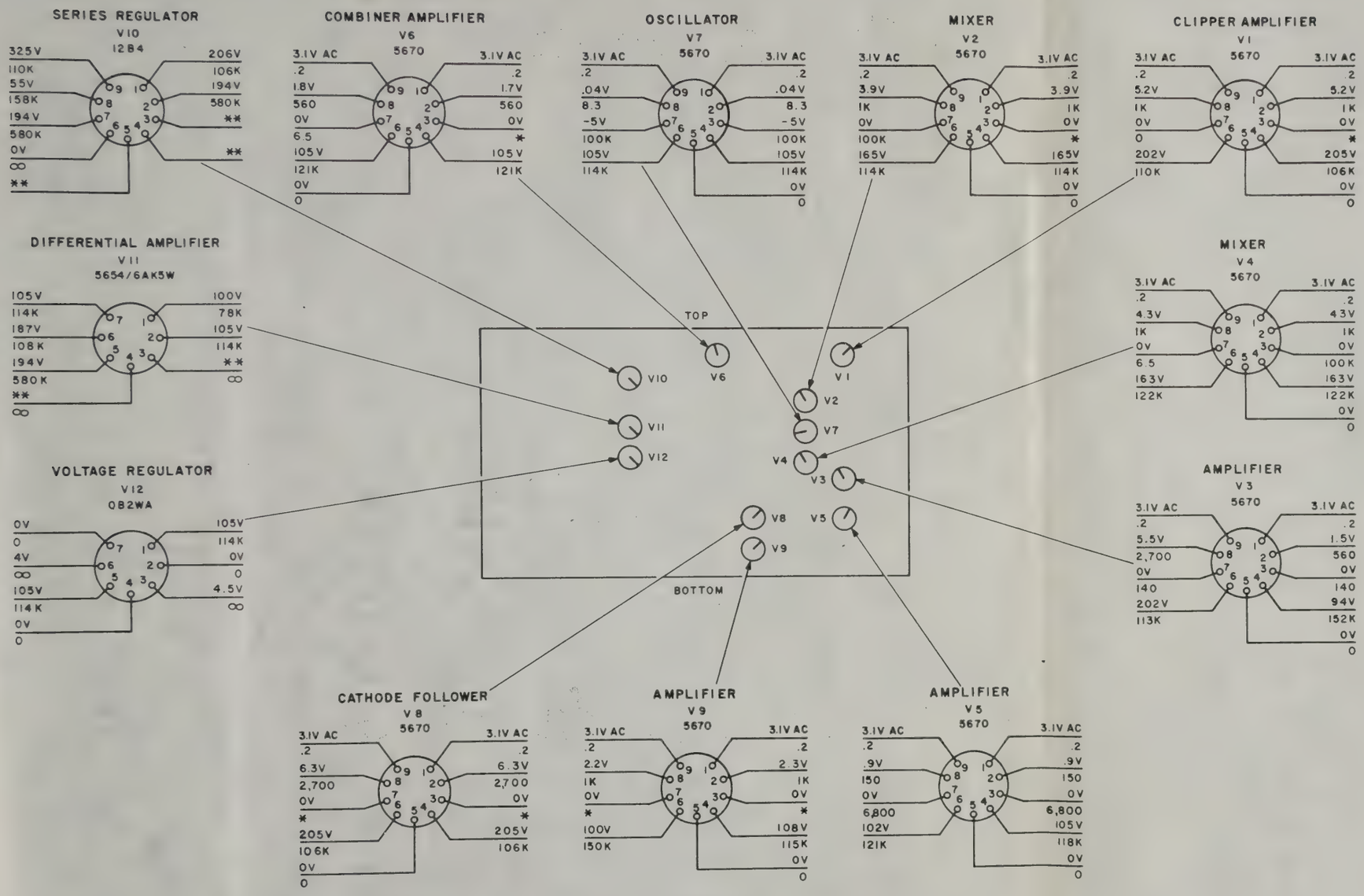
TM5820-469-30-51

Figure 187. Modulator-multiplier, voltage and resistance diagram.



1. VOLTAGES AND RESISTANCES MEASURED TO GROUN WITH VACUUM TUBE VOLTMETER (ME-26/U)
2. VOLTAGE READINGS ARE MADE WITH 115V AC PRIMARY POWER APPLIED, BUT WITHOUT CONNECTIONS TO T SIGNAL JACKS.
3. RESISTANCE MEASUREMENTS WERE TAKEN WITH ON-SWITCH S1 IN THE OFF POSITION AND ALL PLUGS REMO
4. FINAL VOLTAGE READINGS ABOVE THE LINES, AN RESISTANCE READINGS BELOW THE LINES

Figure 188. Multiplexe



NOTES:

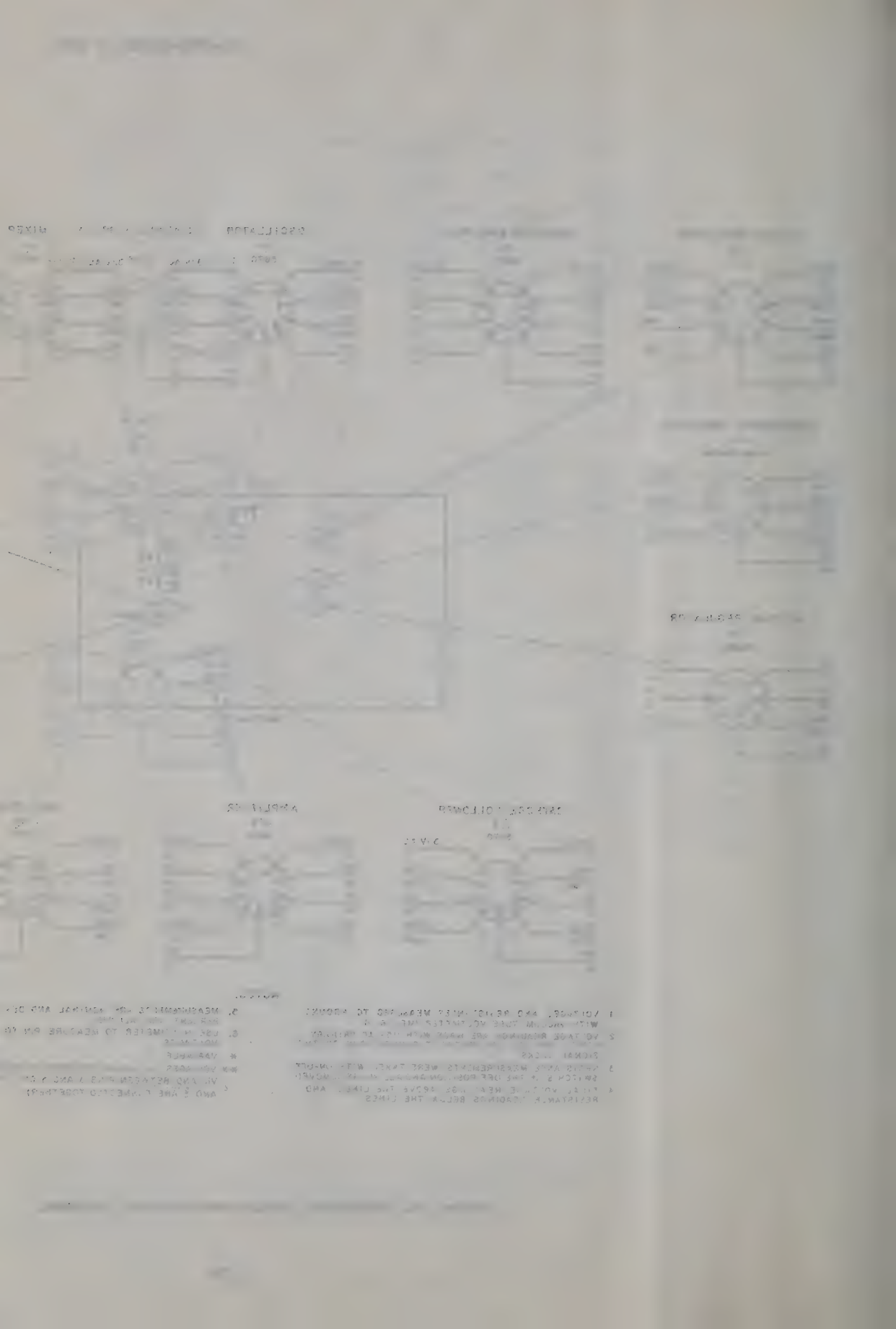
1. VOLTAGES AND RESISTANCES MEASURED TO GROUND WITH VACUUM TUBE VOLTMETER (ME-26/U)
2. VOLTAGE READINGS ARE MADE WITH 115V AC PRIMARY POWER APPLIED, BUT WITHOUT CONNECTIONS TO THE SIGNAL JACKS.
3. RESISTANCE MEASUREMENTS WERE TAKEN WITH ON-OFF SWITCH S1 IN THE OFF POSITION AND ALL PLUGS REMOVED
4. FINAL VOLTAGE READINGS ABOVE THE LINES, AND RESISTANCE READINGS BELOW THE LINES
5. MEASUREMENTS ARE NOMINAL AND DEVIATIONS OF 20 PERCENT ARE ALLOWED
6. USE MULTIMETER TO MEASURE PIN TO PIN FILAMENT VOLTAGES

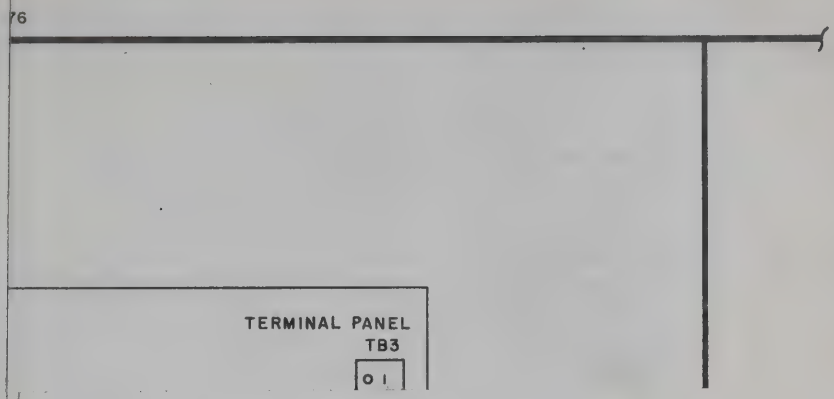
* VARIABLE

** VOLTAGES OF 6.3VAC BETWEEN PINS 3 AND 4 ON TUBE VII, AND BETWEEN PINS 3 AND 5 ON TUBE VIO(PINS 4 AND 5 ARE CONNECTED TOGETHER)

TM5820-469-30-53

Figure 188. Multiplexer, voltage and resistance diagram.




76
TERMINAL PANEL
TB3
01

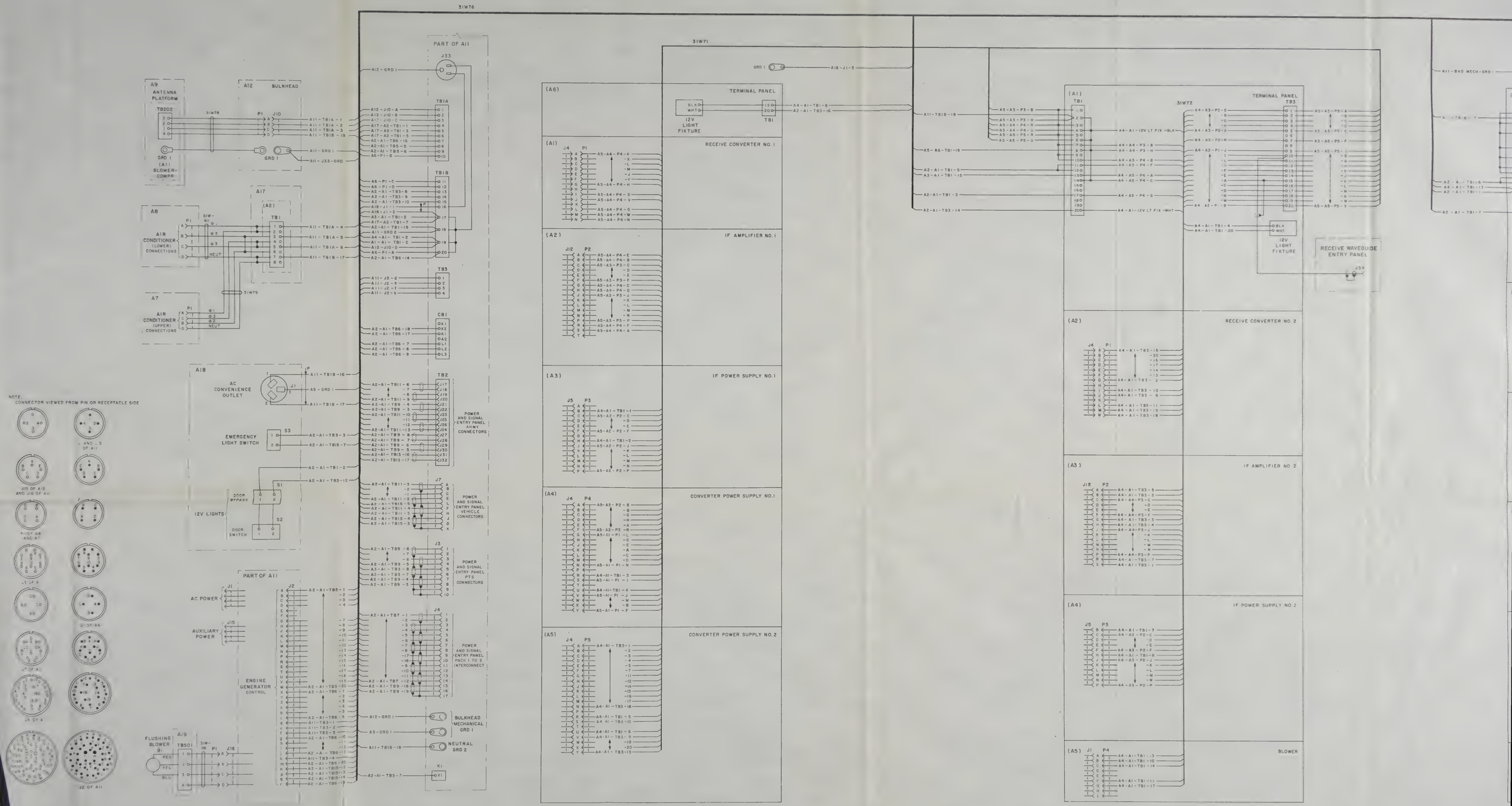
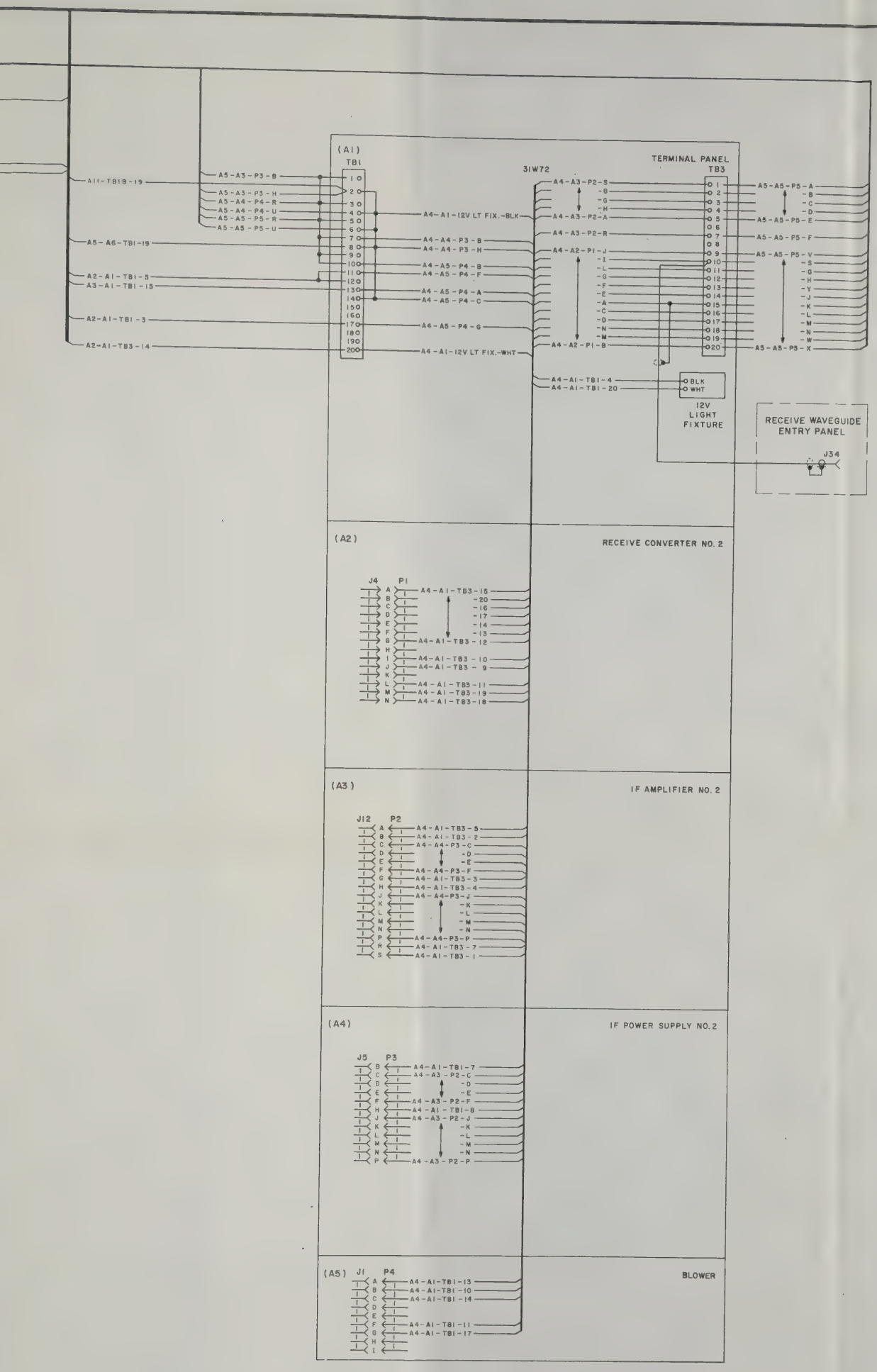
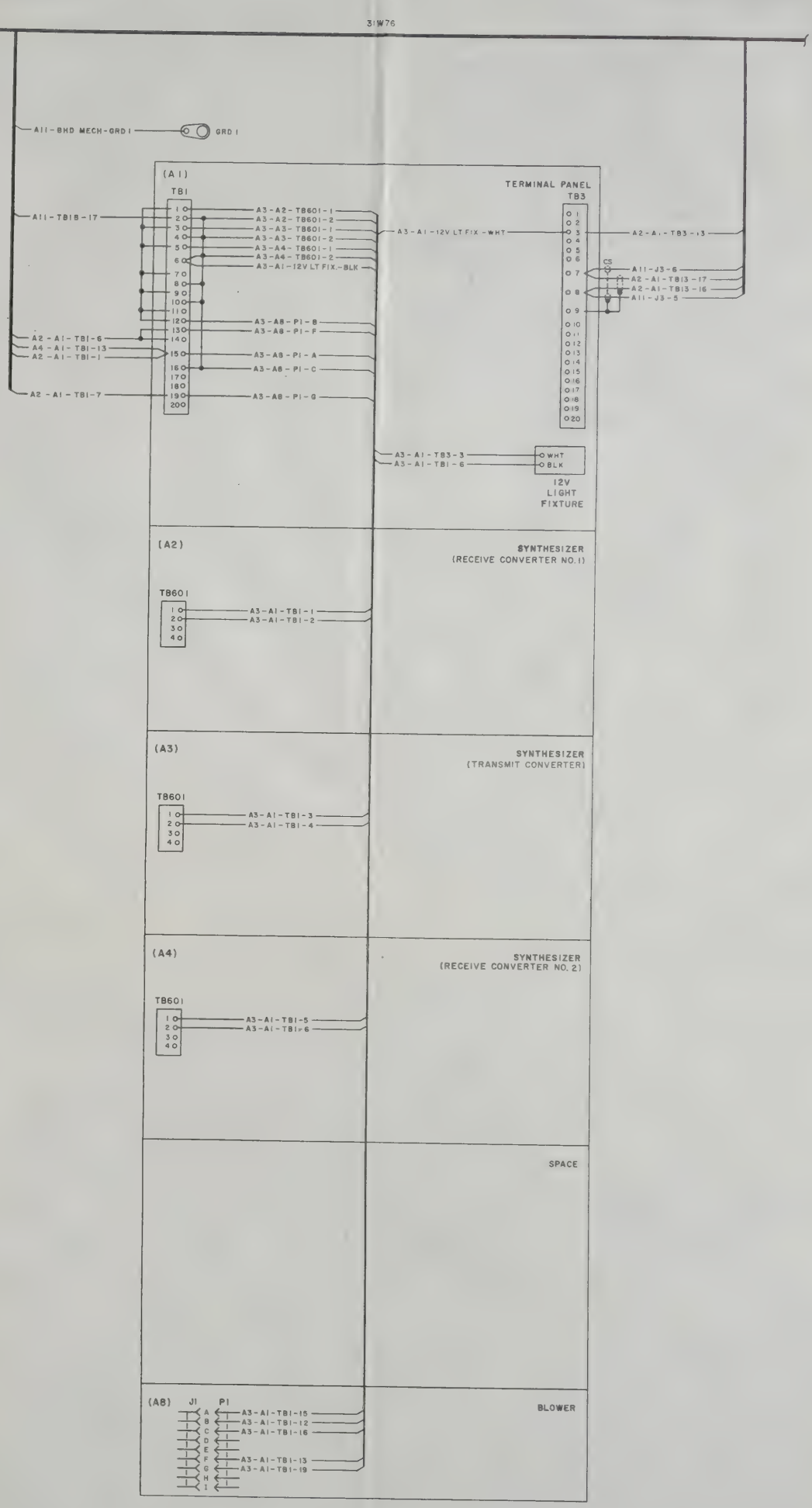


Figure 183. Shelter rack wiring, wiring diagram (part 1 of 2).



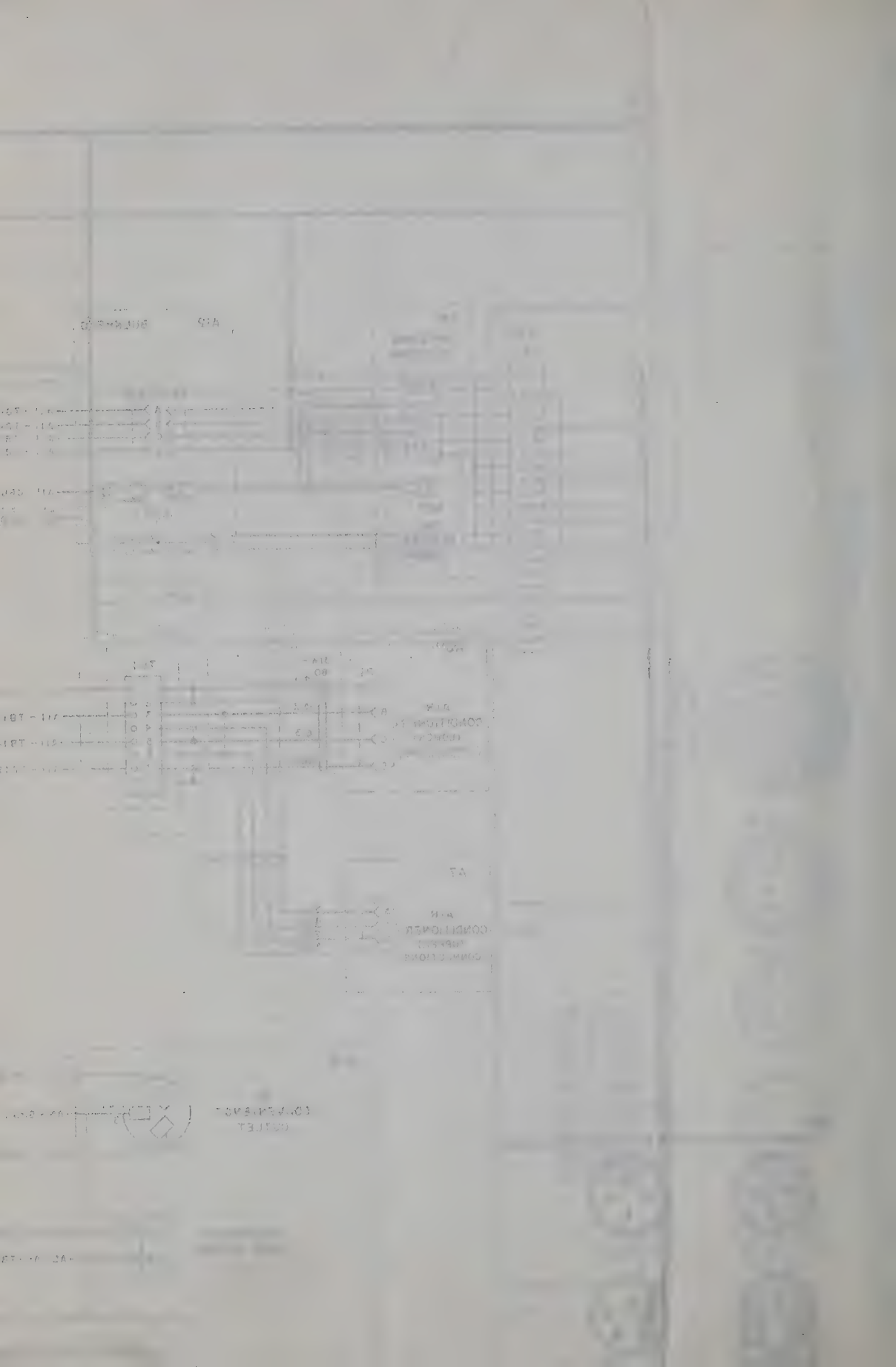
RACK A4

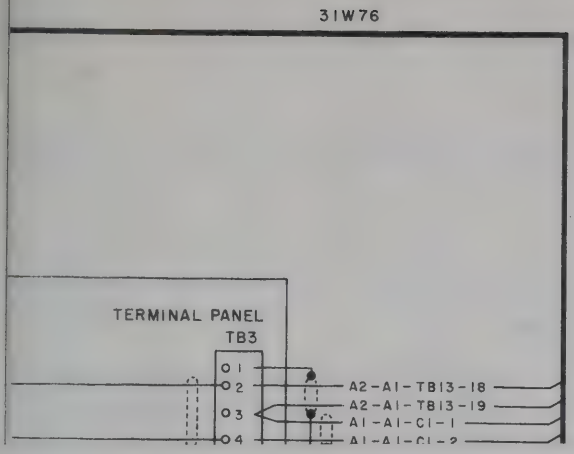


RACK A3

TM5820-469-30-50①

helter rack wiring, wiring diagram (part 1 of 2).




31W76
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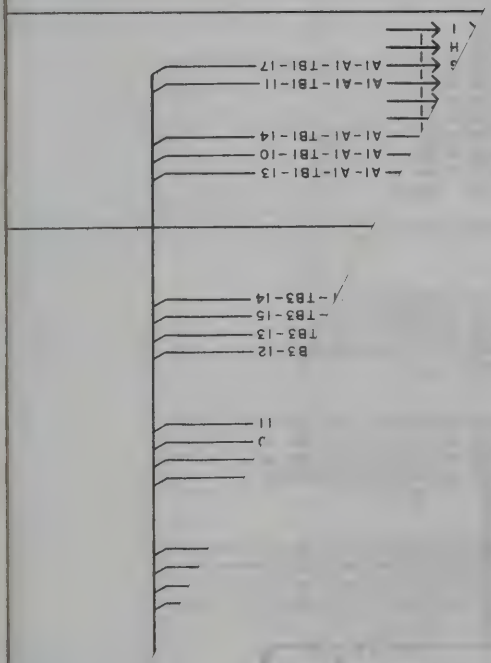
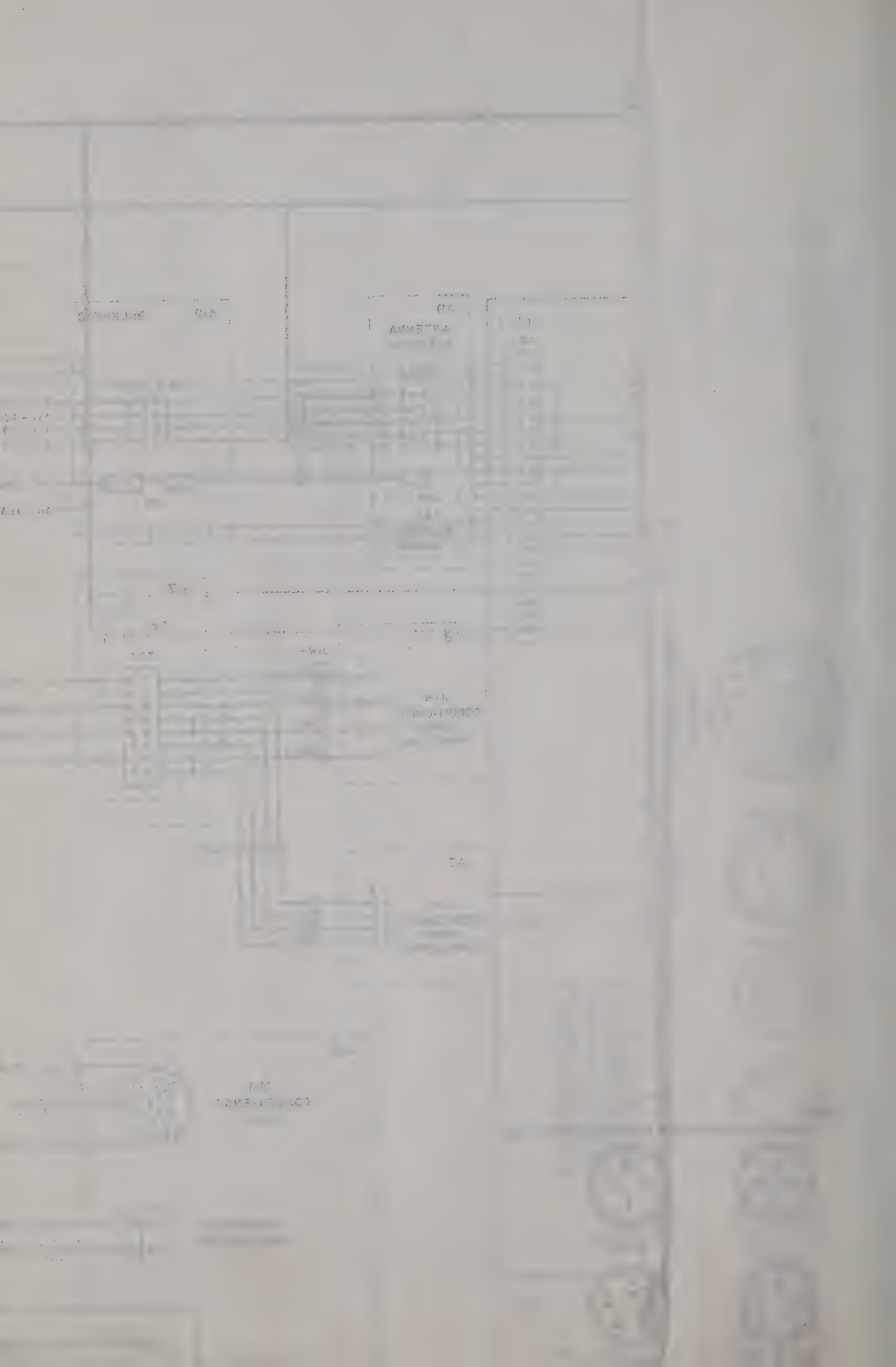
TB3
1
2
3
4
A2-A1-TB13-18
A2-A1-TB13-19
A1-A1-C1-1
A1-A1-C1-2


RACK A1
A1-A1-TB1-17
A1-A1-TB1-11
A1-A1-TB1-14
A1-A1-TB1-10
A1-A1-TB1-13
TB3-14
TB3-15
TB3-13
B3-12
11



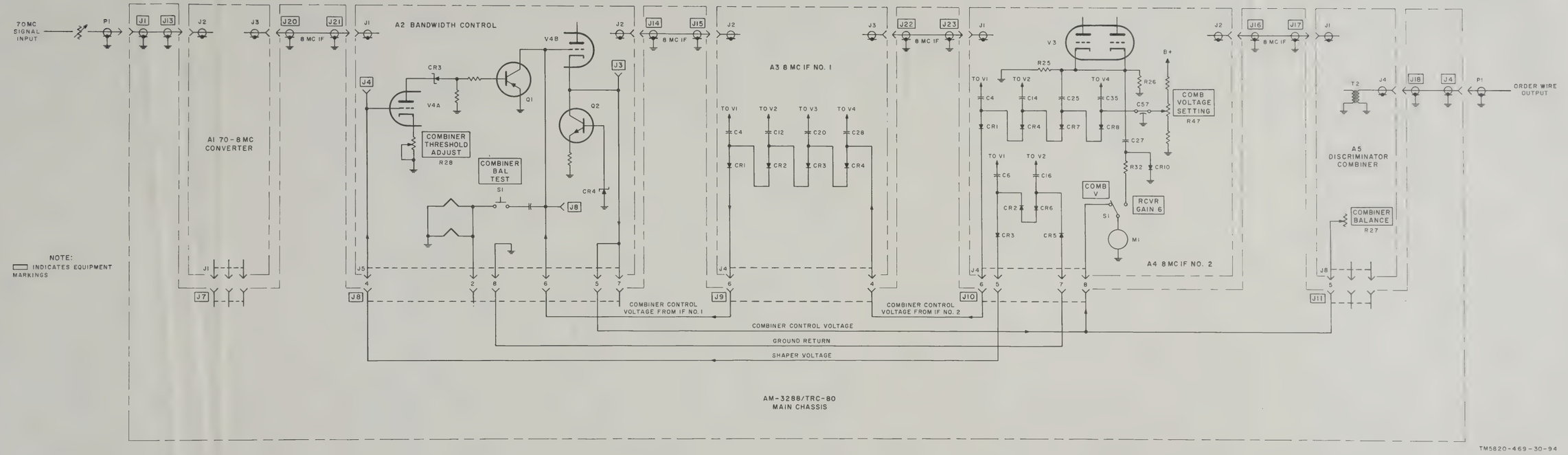
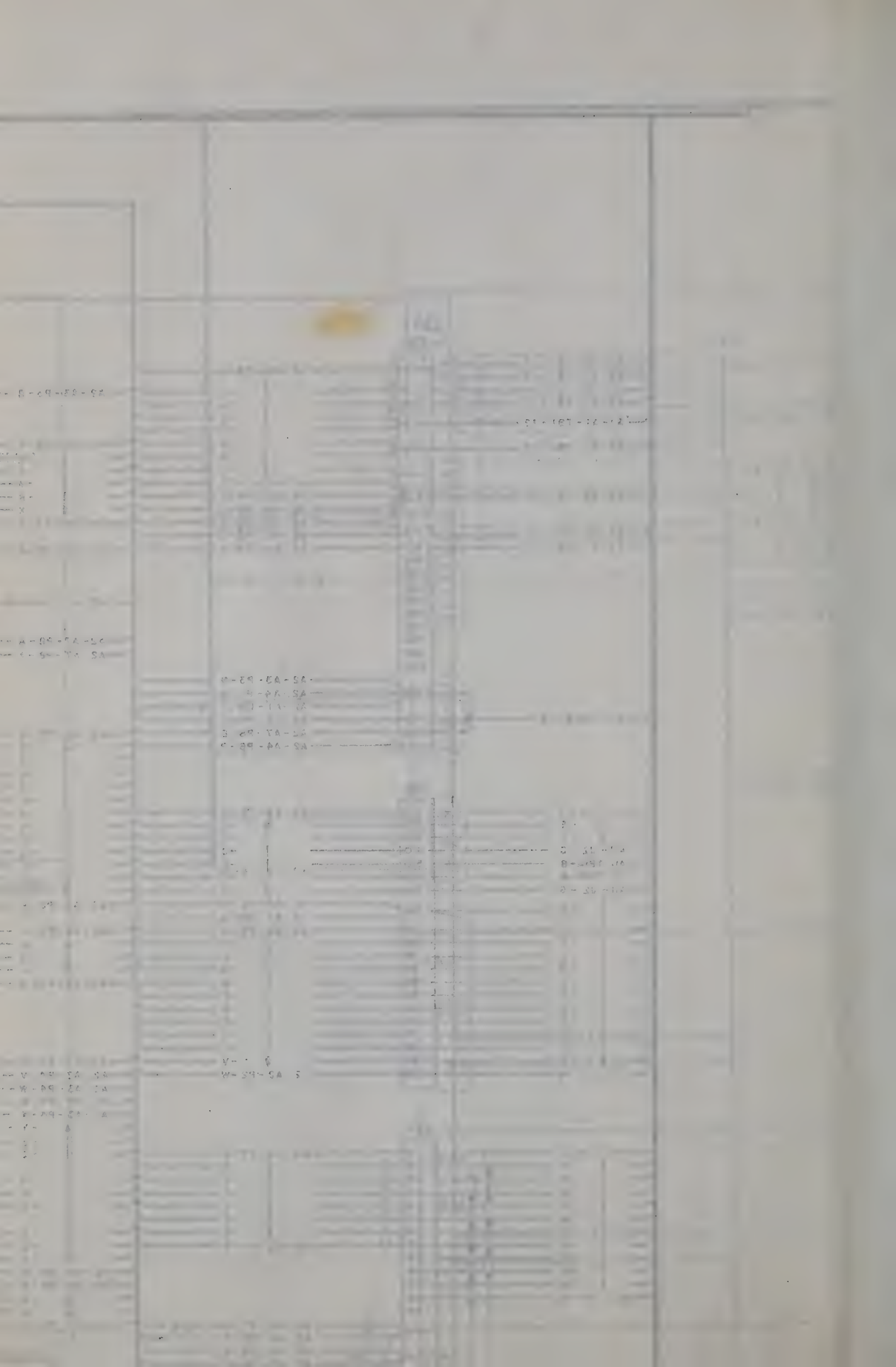
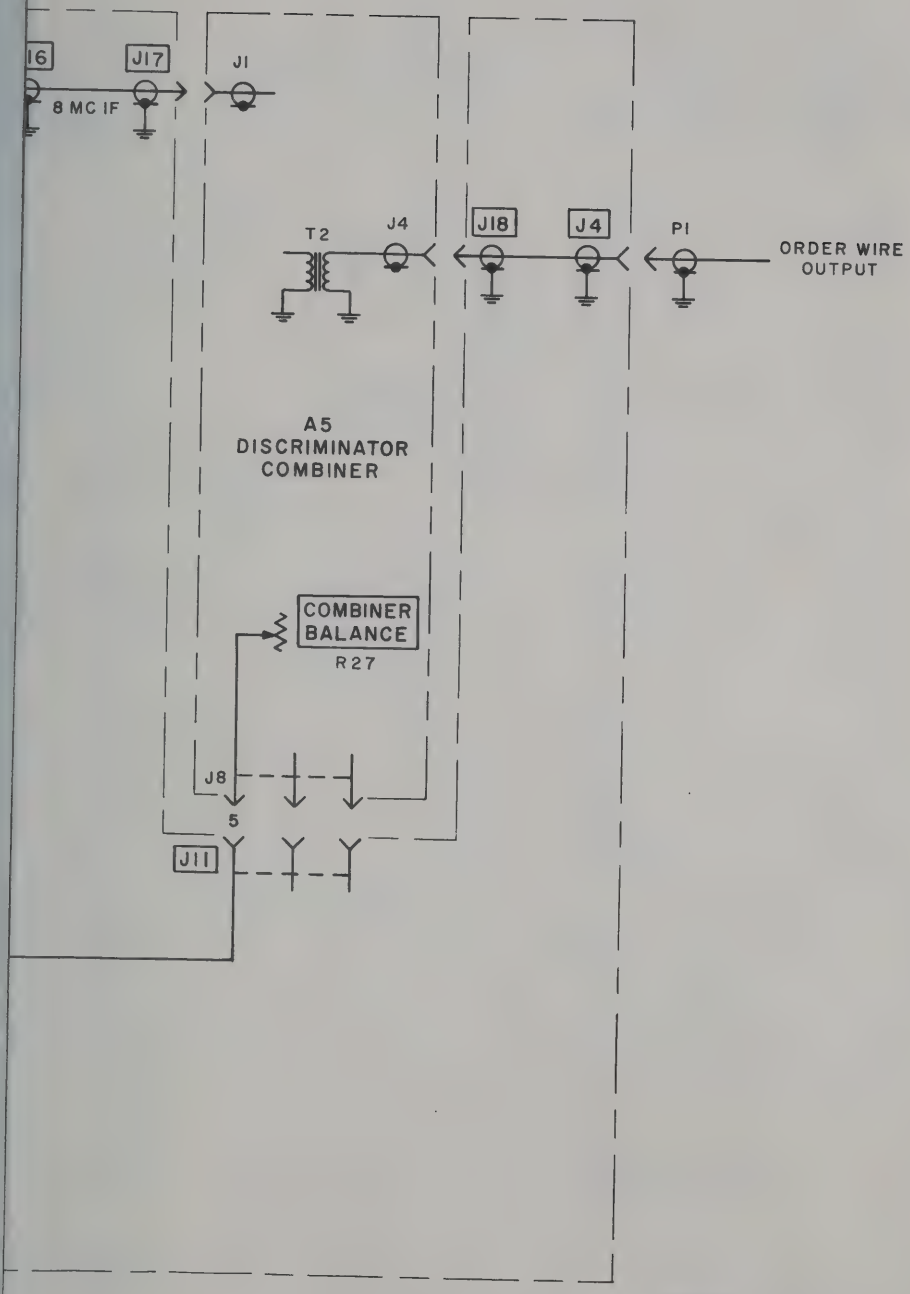


Figure 190. IF amplifier main chassis, distribution of combiner control voltages, schematic diagram.





TM5820-469-30-94

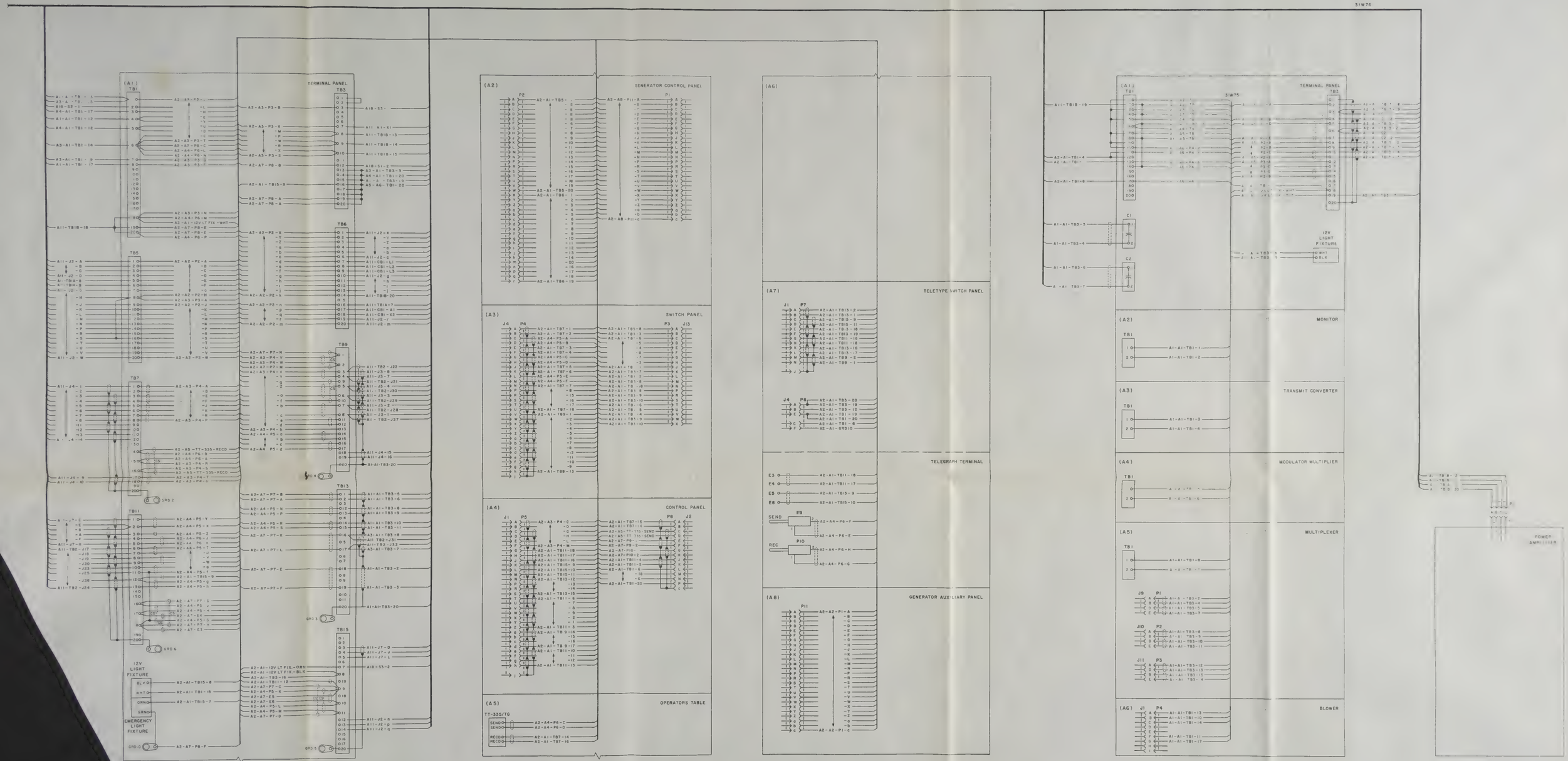


Figure 189. Shelter rack wiring, wiring diagram (part 2 of 2).

APPENDIX

REFERENCE

Following is a list of applicable references available to the direct support maintenance personnel of Radio Terminal Set AN/TRC–80.

AR 40–580	Control of Hazards to Health from Radioactive Materials.
AR 755–380	Disposal of Unwanted Radioactive Material.
DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 4, 6, 7, 8, and 9), Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 5–4120–225–15	Operator, Organizational, Field, and Depot Maintenance Manual: Air Conditioner: Floor Mounting; Electric Motor Driven 1 Hp, Ac, 208 v, 3 Phase, 400 Cycle; 6000 Btu Cooling; 4500 Btu Heating Per Hr. (Redmanson Model CE–6A–400) FSN 4120–062–8578; (Keco Model F–6000) FSN 4120–977–8504; (Therm-air Model CE–6A–400) FSN 4120–062–8578.
TM 5–6115–299–10	Operator's Manual: Generator Set, Gasoline Engine 10 Kw, Ac, 120/208 v, 3 Phase, 400 Cycle, Skid Mounted (Bogue Electric Model 5380A) FSN 6615–972–2326 (or 6115–855–9572).
TM 5–6115–299–20	Organizational Maintenance Manual: Generator Set, Gasoline Engine, 10 Kw, Ac, 120/208 v, 3 Phase, 400 Cycle, Skid Mounted (Bogue Electric Model 5380A) FSN 6115–972–2326 (or 6115–855–9572).
TM 5–6115–299–35	Field and Depot Maintenance Manual: Generator Set, Gasoline Engine: 10 Kw, Ac, 120/208 v, 3 Phase, 400 Cycle, Skid Mounted (Bogue Electric Model 5380A) FSN 6115–972–2326 or 6115–855–9572).
TM 11–668	F-M Transmitters and Receivers.
TM 11–685	Fundamentals of Single-Sideband Communications.
TM 11–1257	Signal Generator AN/URM–48.
TM 11–2208	Test Sets: TS–2/TG, TS–2A/TG, TS–2B/TG and TS–2C/TG (Teletypewriter, Signal Distortion).
TM 11–5057	Frequency Meter AN/USM–26.
TM 11–5088	Generators, Signal SG–71/FCC, SG–71A/FCC, and SG–71B/FCC.
TM 11–5095	Frequency Meter AN/URM–80.
TM 11–5527	Multimeters TS–352/U, TS–352A/U, and TS–352B/U.
TM 11–5805–246–10	Operator's Manual: Terminal, Telegraph TH–5/TG.
TM 11–5805–246–35	Field and Depot Maintenance Manuals Terminal, Telegraph TH–5/TG.
TM 11–5815–206–35	Field and Depot Maintenance Manual: Teletypewriter Set AN/PGC–1 and Teletypewriters TT–4A/TG, TT–4B/TG, TT–4C/TG, and TT–335/TG.
TM 11–5820–469–10	Operator's Manual: Radio Terminal Set AN/TRC–80.

TM 11–5820–469–20	Organizational Maintenance Manual: Radio Terminal Set AN/TRC–80
TM 11–6625–200–12	Operator and Organizational Maintenance Manual: Multimeters ME–26A/U and ME–26B/U.
TM 11–6625–248–12	Operation and Organizational Maintenance: Radio Frequency Power Test Set AN/USM–96.
TM 11–6625–274–12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV–7/U, TV–7A/U, TV–7B/U, and TV–7D/U.
TM 11–6625–320–12	Operator's and Organizational Maintenance Manual: Voltmeter, Meter ME–30A/U and Voltmeters, Electronic ME–30B/U and ME–30C/U.
TM 11–6625–400–12	Operator and Organizational Maintenance Manual: Meter, Modulation ME–57/U.
TM 38–750	Army Equipment Record Procedures.

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